2002 High Occupancy Vehicle (HOV) Lane Master Plan Update

Final Summary Report

March 2003

Prepared for
Metropolitan Transportation Commission,
Caltrans District 4 and the
California Highway Patrol Golden Gate Division

By
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In association with

Parsons Brinckerhoff
ATD Northwest

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1 PROJECT PURPOSE AND BACKGROUND

The Metropolitan Transportation Commission (MTC) was created by the state Legislature in 1970 to provide transportation planning for the nine-county San Francisco Bay Area. MTC functions as both the regional transportation planning agency (RTPA) – a state designation – and for federal purposes, as the region's metropolitan planning organization (MPO). As such, MTC has undertaken an updating of its *1997 HOV Lane Master Plan* as part of its regional transportation planning and coordination responsibilities. The development of the *2002 HOV Lane Master Plan* reflects an ongoing interest in existing HOV lane operations and in expanding HOV lane use by regional express buses.

MTC also has assessed the contribution that expansion of the HOV lane system and the expansion of express bus operations can make toward improvement of air quality in the Bay Area. The Bay Area's recently adopted *2001 Ozone Attainment Plan* includes the examination of HOV lane facilities' potential air quality benefit as a "further study measure." Further Study Measures may or may not be included in the Ozone Plan, depending on the results of the analysis and other related factors.

The *2002 HOV Lane Master Plan* includes a thorough review of current HOV lane performance. An assessment of HOV lane forecasts (2025) from the latest modeling conducted for the *2001 Regional Transportation Plan* (RTP), and more current forecasts (2010) developed specifically for this plan (see Section 11) also were completed. This assessment has led to the development of recommendations for how the HOV lane system could be expanded beyond what is already included in the 2001 RTP. HOV lane improvements that support further development of MTC's Regional Express Bus Program also have been of particular interest as part of the plan update, and the study includes recommendations for expansion of the express bus operations in the region. Also included as part of the study were:

- A vehicle license plate and user survey to evaluate carpooler characteristics and attitudes
- A review of current policies for HOV lane hours of operation and occupancy requirements
- An analysis of the potential for additional HOV freeway-to-freeway connectors and direct HOV access ramps
- A look at improved HOV lane enforcement
- A review of past and ongoing Bay Area congestion pricing studies and their potential application to the HOV lane system
- Updated costs of recommended HOV and HOV support facilities (e.g. park and ride lots, bus stops/shelters, etc.)
- Analysis of the potential for spot use of some freeway shoulders for express buses

The first regional HOV master plan, which was adopted in 1990, identified 470 potential new miles of HOV lanes in addition to the 64 lane miles already then in place. That master plan became the system blueprint for federal, state, regional and local HOV lane funding over the next twelve years. By 1996 there were 270 miles of HOV lanes, as well as HOV by-passes at bridge toll booths and many of the freeway ramp meters. In 1997, MTC updated the regional

HOV Master Plan and brought it in line with the requirements for the MTC RTP to be financially constrained to reasonably available funding over a 25-year period. The plan proposed the addition of 149 new HOV lane miles to the then existing system of 270 lane miles.

The *2002 HOV Lane Master Plan* has given MTC the opportunity to review the significant developments in regional infrastructure, construction and programming that have occurred over the past five years, and provides an assessment of the implications for future HOV lane system development.

There are currently about 300 freeway HOV lane miles and 50 expressway HOV lane miles as indicated in Figures 1 and 2. In addition, there are

- 16 arterials with 13 lane miles of HOV or bus-only lanes.
- 4 bridge toll plazas with exclusive HOV lanes (HOVs pass free on all toll bridges during designated hours),
- 4 HOV freeway-to freeway connectors,
- 2 HOV-only freeway on ramps, and
- 66 HOV bypass lanes at metered freeway on-ramps.

Also indicated in Figures 1 and 2 are HOV lanes that are already funded or under construction and included in the *2003 Transportation Improvement Program* (TIP). The 2003 TIP and 2001 RTP expand the current 2002 HOV system as indicated in Table 1.

Table 1 - Already Planned HOV Lane Improvements

HOV Lane Miles	Current (2002)	2003 TIP	2001 RTP	Increase from Current to 2001 RTP
Freeway	298	368	512	214
Expressway	50	50	66	16
Total	348	418	578	230

Much of the growth in the Bay Area over the past 10 years has occurred in the region's suburbs, and not in the traditional central cities. This dispersion of travel over more origins and destinations has created significant new suburban freeway congestion and a need for more flexible modal options for meeting commute travel needs. Carpooling, vanpooling and express bus services have become increasingly more important to meeting the mobility needs of the region as the decentralization of population and employment has occurred.

The results of this study will provide MTC and its partner agencies with the information needed to make the important policy decisions about HOV lane system investments for the next 20 years. This study will provide the needed information about which operational changes, eligibility rules, enforcement methods, support facilities, express bus services and new infrastructure investments will optimize the value of the HOV lane system in providing regional mobility safely and efficiently.

FIGURE 1

Bay Area Existing and Funded HOV Lane Master System

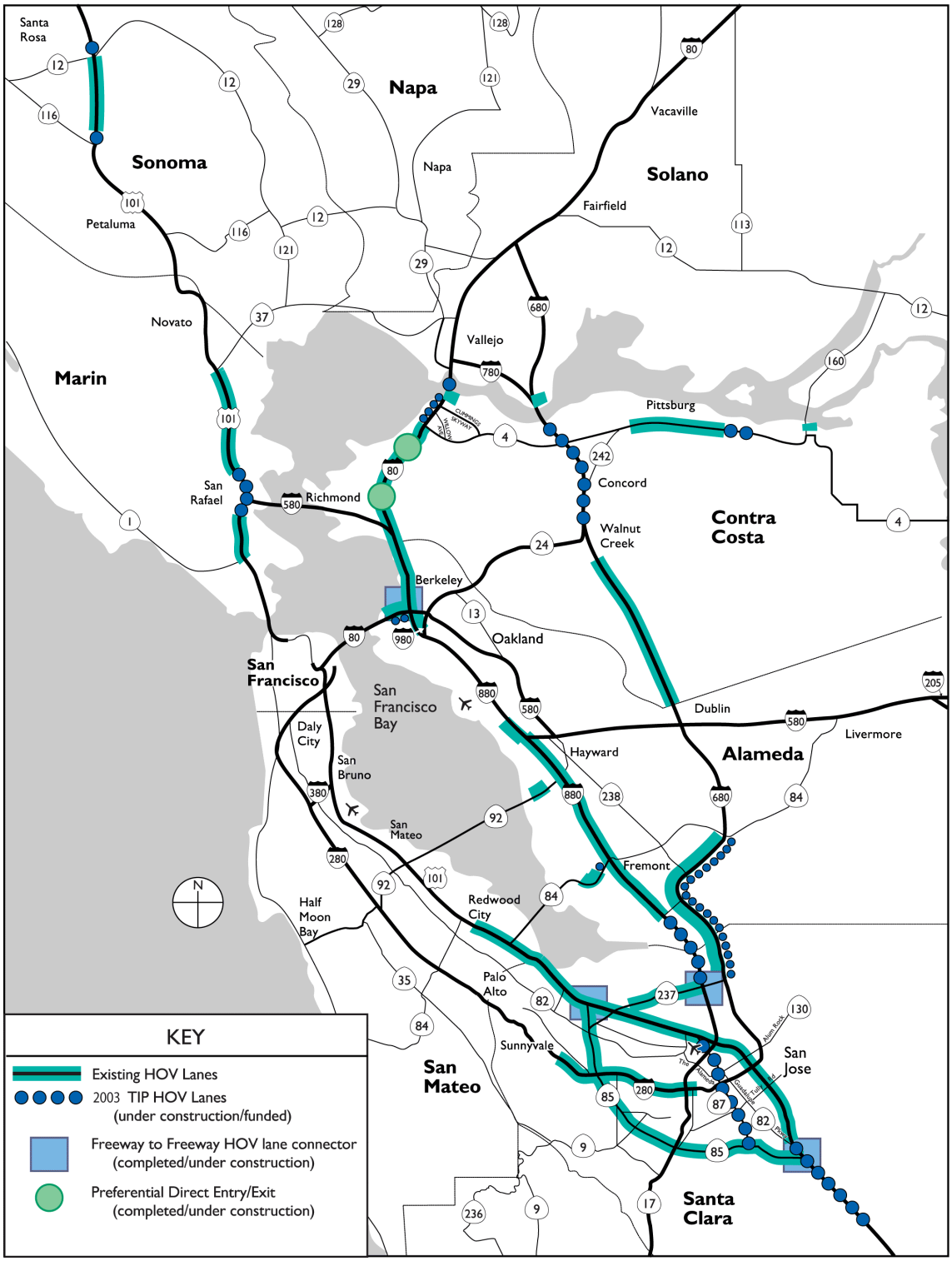
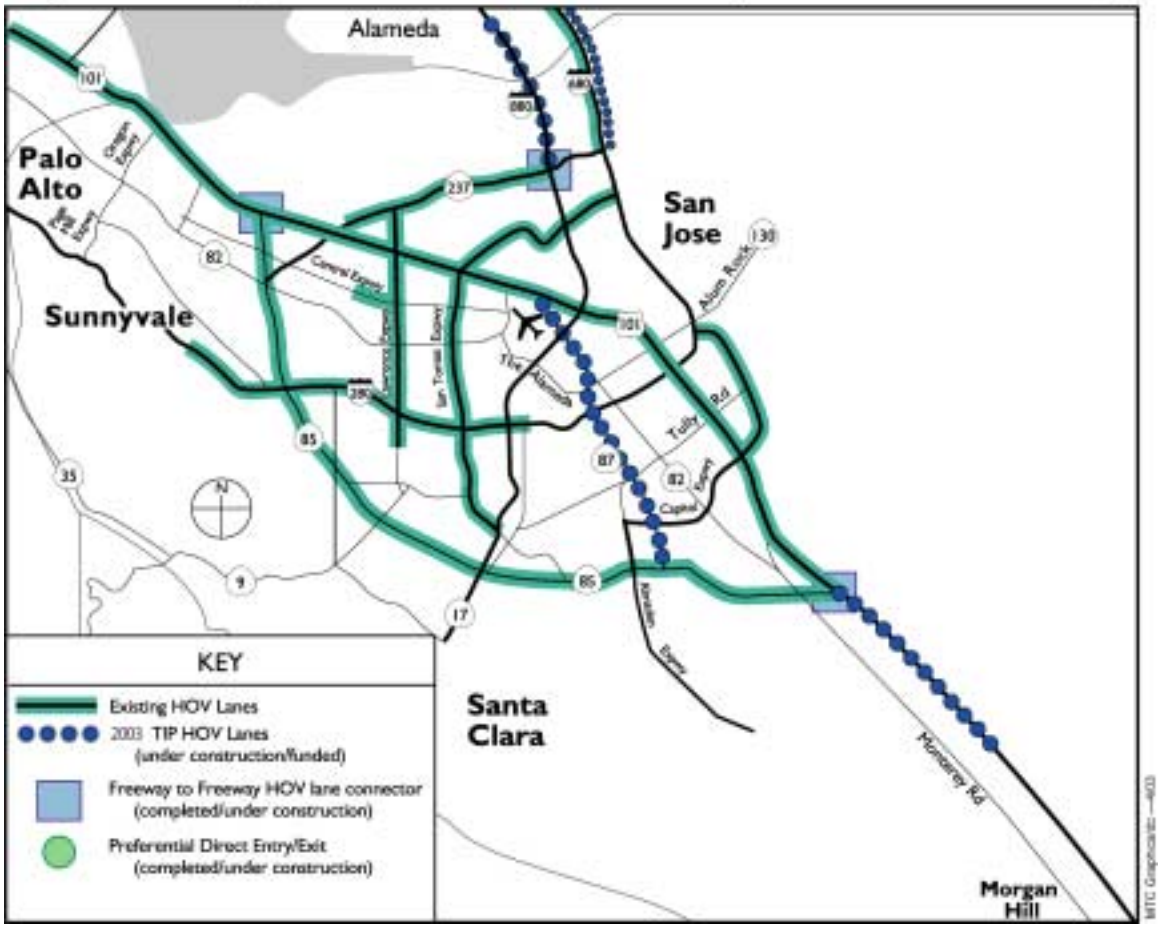


FIGURE 2

Bay Area Existing and Funded HOV Lane Master System: Santa Clara County



2 KEY FINDINGS AND RECOMMENDATIONS

MTC committed to evaluate several aspects of the region's HOV and express bus systems as part of "Further Study Measure 2" included in the adopted 2001 Ozone Plan. A brief summary of preliminary findings and recommendations is as follows:

- What does the public think of HOV lanes? – According to recently conducted license plate and Web surveys conducted by MTC, Bay Area HOV lanes are supported by carpoolers and non-carpoolers alike.
- How well are HOV lanes used now and how well will they be used in the future? - Nearly all existing peak direction freeway HOV lanes meet established Caltrans performance standards. Fewer off-peak direction HOV lanes meet standards currently, but nearly all will between 2010 and 2025. Staff recommends that Caltrans, in accordance with the "I-80 Project Assurances," (adopted by MTC to oversee Contra Costa and Alameda I-80 operations) evaluate lifting the I-80 HOV lane restrictions in the off-peak direction (eastbound a.m. and westbound p.m.) and that other HOV lanes continue to be monitored for possible adjustments to the hours of operation, especially in the off-peak direction.

The Santa Clara County Roads and Airport Department currently is evaluating its expressways' HOV lane performance; the forthcoming report may recommend that portions of County expressway HOV lanes be de-designated due to poor performance.

- How significant are HOV lane violation rates and how can CHP enforcement be improved? - Most HOV lanes have observed violation rates within acceptable Caltrans standards (below 10 percent), with the notable exception being the region's most heavily used HOV facility: I-80 westbound to San Francisco. The generally low observed violation rate is due to the generally high HOV lane use, an aggressive CHP enforcement program and high fines (second highest in the country). HOV lane enforcement funding will need to increase as the region's HOV lane system continues to grow.
- Are changes to HOV lane occupancy requirements being considered at this time? - No. Current HOV lane operations indicate the existing occupancy requirements are adequate. However, MTC projections indicate that high HOV lane vehicle volumes will significantly degrade HOV lane travel time savings on most peak direction HOV lanes after 2010.
- How can we improve HOV lane person-carrying capacity? - The region's express bus services and infrastructure to support these services should be expanded, particularly where rail services do not exist. Priority express bus corridors are: I-680, I-80 and US 101 (Sonoma/Marin counties).
- Should HOV lanes be converted to bus-only lanes? - It is unlikely that the number of freeway express buses will be great enough to warrant conversion to bus-only lanes. In addition, such conversions would force carpool and vanpool vehicles into already crowded mixed-flow lanes.
- Should freeway shoulders be used for peak-period bus use? - The evaluation indicates that there are some congested freeway segments where the shoulder may be available to accommodate HOV lane use. Caltrans does not support using shoulders for bus-only lanes that are contiguous to existing part-time HOV lanes due to potential confusion between the buses and HOVs. Caltrans, the CHP and MTC will conduct a more thorough assessment of candidate shoulder segments that could be used to extend or close HOV lane gaps.
- How feasible would it be to allow non-carpools (drive alones or commercial vehicles) to use HOV lanes by paying a toll (know as high-occupancy-toll, or HOT lanes)? - Most Bay Area HOV lanes are well used now and will not have sufficient capacity to "sell" as demand grows. Implementing HOT lanes may be a strategy to consider in some corridors to regulate users when HOV demand exceeds HOV lane capacity. Over the long term, there are six corridors where excess HOV lane capacity, particularly in the off-peak direction, may be available to sell in order to fully utilize freeway capacity.
- How much will it cost to implement the HOV Lane Master Plan? - The plan is estimated to cost about $3.7 billion to complete. Discounting lower priority (Priority 2) recommended improvements ($1 billion), which will likely require new revenue sources beyond those typically considered available in the RTP, almost three-fourths of the recommended improvements are already committed ($1.2 billion programmed in the TIP and another $770 million committed in the later years of the 2001 RTP).
- What the air quality benefits of HOV lanes? – HOV lane alternatives show lower regional emissions than mixed flow lane alternatives.

3 WHAT DOES THE PUBLIC THINK OF HOV LANES?

One key task of the plan update was to determine public perception of HOV lanes in general, and to solicit ideas on how the lanes should be operated and enforced. Two surveys were conducted as part of the plan update: 1) License plate survey of carpool lane users – 5600 surveys sent/1,300 surveys returned; and 2) Web survey for carpool and non-carpool lane users – over 5,000 responses. Findings from these two surveys are as follows:

- Respondents Support HOV lanes: 60 percent of those responding to the Web survey supported Bay Area HOV lanes; 85 percent of those responding who indicated regular (two to three times or more per week) HOV lane use supported HOV lanes, compared to almost 50 percent of non-carpoolers (less than once a week) who responded who also support HOV lanes.
- General satisfaction with HOV lane use among carpoolers: 68 percent of regular carpoolers responding think HOV lanes are well used, while 73 percent of the non-users responding tend to think HOV lanes are under used.
- Most carpool with family members or co-workers: 75 percent of surveyed carpool drivers commute with family members or co-workers; 18 percent of those surveyed drove with "casual" carpoolers.
- Most carpoolers think that HOV lanes provide substantial travel time savings: 72 percent of the respondents to the carpool lane user survey indicated that HOV lanes "greatly reduces" commute travel time.
- Most think that HOV lane enforcement needs to be increased: 51 percent of the Web survey respondents thought that enforcement was not adequate.
- Most do not support increasing HOV lane vehicle occupancy requirements: Nearly 80 percent of Web survey respondents did not support increasing HOV lanes that require two or more (2+) occupants to three or more (3+) occupants.

4 EVALUATION OF THE SYSTEM'S PERFORMANCE

The *2002 HOV Lane Master Plan Update* includes an evaluation of existing and planned HOV lanes. Caltrans also assesses HOV use at toll gates during designated hours, but these are not specifically analyzed here and are generally considered part of the freeway HOV lanes. Proposed additions to the HOV lane system included in the *2001 Regional Transportation Plan* or already in the *Regional Transportation Improvement Program* were included in the evaluation. The HOV lanes were evaluated on the basis of their performance as indicated by four primary measures:

- Total vehicle usage per average a.m. weekday peak hour
- Total person usage per average a.m. weekday peak hour
- Lane productivity: the ratio of people per lane per hour in the HOV lane to people per lane per hour in the adjacent mixed-flow lanes
- Travel-time savings per mile.

Caltrans has established performance standards with respect to three of these measures. The standards suggest that an HOV lane should generate at least 800 vehicles per lane per hour or carry at least 1,800 people per lane per hour. They also suggest that an HOV lane should provide a travel time-savings of at least one minute per mile.

Count data provided by Caltrans was used to evaluate the current performance of the freeway HOV lanes in every county except in Santa Clara County. Data provided by Santa Clara

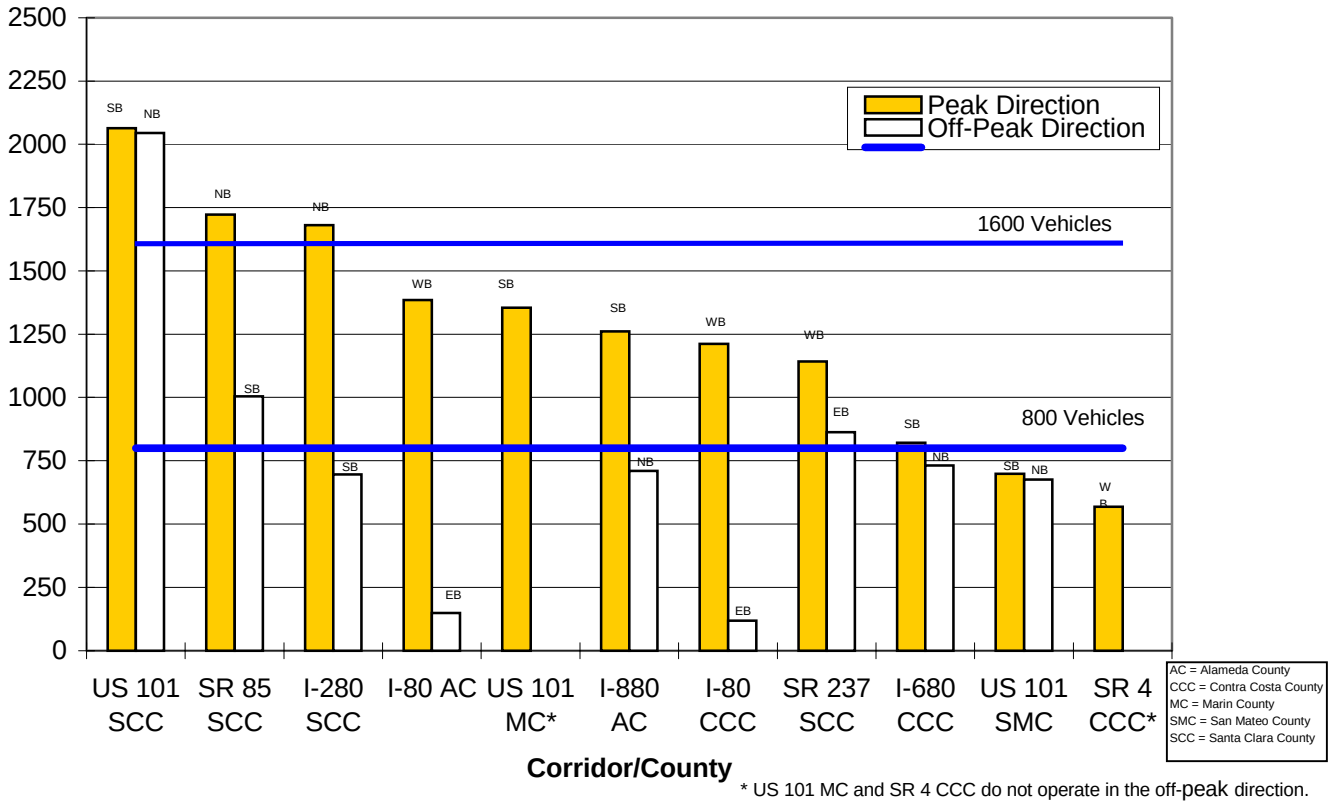
County and the Santa Clara Valley Transportation Authority were used to evaluate the freeways and expressways in Santa Clara County. To be consistent with the long-range planning horizon of the RTP, the future performance of existing and planned freeway HOV lanes was evaluated using model forecasts produced by MTC for 2025 in the 2001 RTP. Travel forecasts produced by VTA were used to evaluate the future performance of the Santa Clara County expressways.

The performance statistics presented in this section are for both the peak and off-peak direction. Some of the key performance measures are summarized in Table 2 for the peak direction and in Table 3 for the off-peak direction. As shown in Figures 3-7, HOV travel flows are fairly balanced in some corridors between directions, while in others there is a clear distinction between the two directions.

HOV Vehicle Volumes

The analysis of current performance indicates that the HOV lane system is contributing significantly to regional mobility as indicated in Figure 3, which ranks the existing HOV segments by HOV vehicles in the a.m. peak hour/peak direction.

FIGURE 3
2001 AM Peak Hour HOV Lane Vehicle Use



* US 101 MC and SR 4 CCC do not operate in the off-peak direction.

Table 2 - Summary of HOV lane Use and Productivity Analysis for Peak Direction

Corridor	A.M. Peak Direction	2001 HOV Lane Volume	2001 HOV Productivity	2025 HOV Lane Volume (vehicles)[1]	2025 HOV Lane Productivity[1]
FREEWAYS					
Alameda, I-80	WB	1,385	2.5	1,572 - 1,944	2.5 - 3.3
Alameda, SR 84	WB	1,335	2.1	1,344 - 1,357	1.7 - 1.7
Alameda, SR 92	WB	650	0.9	949 - 1,010	1.0 - 1.1
Alameda, I-580	WB	-	-	2,198 2,739	1.6 2.2
Alameda, I-680	SB	-	-	2,473 - 2,476	2.5 - 2.5
Alameda, I-880	SB	1,261	1.9	2,107 - 2,195	2.6 - 3.1
Contra Costa, SR 4	WB	568	0.6	808 - 1161	0.8 - 1.2
Contra Costa, I-80	WB	1,211	2.2	1,616 1,682	2.5 2.6
Contra Costa, I-680	SB	821	1.0	1,747 - 1,790	2.3 - 3.1
Marin, US 101	SB	1,354	3.0	1,952 - 1,958	5.2 - 5.3
Santa Clara, SR 85	NB	1,723	3.9	2300 - 2321	3.7 - 4.0
Santa Clara, SR 87	NB	-	-	2,645 - 3,175	2.3 - 3.2
Santa Clara, US 101	SB	2,064	3.3	2,202 - 2,448	2.6 - 3.2
Santa Clara, SR 237	WB	1,142	2.2	2,249 - 2,324	4.0 - 4.3
Santa Clara, I-280	NB	1,680	2.1	2,264 - 2,439	2.5 - 2.9
Santa Clara, I-680	SB	-	-	1,569 - 1,946	1.7 - 2.4
Santa Clara, I-880	SB	-	-	2,459 - 2,951	2.2 - 3.1
San Mateo, US 101	SB	698	1.2	1,362 - 1,434	1.9 - 2.0
Solano, I-80	WB	-	-	2,270 - 2,406	3.0 - 3.6
Sonoma, US 101	SB	-	-	1,348 - 1,367	3.5 - 3.5
EXPRESSWAYS					
Lawrence Expressway	NB	376	0.7	376	0.8
Montague Expressway	WB	208	0.5	208	0.4
Central Expressway	WB	84	0.2	88	0.2
San Tomas Expressway	NB	292	0.6	369	0.7

Notes:

1. Forecasts of future HOV lane use do not include possible lane violations. The lower end of the range for freeway HOV lanes represents the share of eligible vehicles using the lane as predicted by MTC's regional travel model. The high end of the range assumes that all eligible vehicles use the HOV lane. Expressway HOV lane volumes were forecasted by CCS Planning and Engineering Inc. using the Santa Clara CMA 2025 travel model and no range was presented. There also were no estimates of speed on expressway HOV lanes.

Source: DKS Associates

Table 3 - Summary of HOV lane Use and Productivity Analysis for Off-Peak Direction

Corridor	A.M. Peak Direction	2001 Off-Peak HOV Volume	2001 Off-Peak HOV Productivity	2025 HOV Lane Volume (vehicles)[1]	2025 HOV Lane Productivity[1]
FREEWAYS					
Alameda, I-80	EB	149	0.5	182 - 426	0.3 - 0.8
Alameda, I-580	EB	-	-	983 1276	1.1 1.5
Alameda, I-680	NB	-	-	1,543 - 1,545	1.8 - 1.9
Alameda, I-880	NB	709	1.9	977 - 1081	1.9 - 2.1
Contra Costa, SR 4[2]	EB	-	-	943 - 951	1.3 - 1.3
Contra Costa, I-80	EB	119	0.3	159 400	0.3 0.9
Contra Costa, I-680	NB	731	0.9	1,461 - 1,549	3.7 - 4.2
Marin, US 101[2]	NB	-	-	1,166 - 1,273	1.4 - 1.5
Santa Clara, SR 85	SB	1,004	1.1	1,095 - 1,518	1.2 - 1.4
Santa Clara, SR 87	SB	-	-	887 - 1,151	1.8 - 2.6
Santa Clara, US 101	NB	2,044	2.3	2,178 - 2,367	2.1 - 2.8
Santa Clara, SR 237	EB	863	1.4	1,378 - 1,450	1.5 - 1.8
Santa Clara, I-280	SB	696	0.9	687 - 1282	0.6 - 1.4
Santa Clara, I-680	NB	-	-	1,231 - 1,263	1.2 - 1.3
Santa Clara, I-880	NB	-	-	1,194 - 1,426	1.3 - 1.8
San Mateo, US 101	NB	677	1.2	1,139 - 1,477	1.2 - 1.7
Solano, I-80	EB	-	-	1,576 - 1,576	2.3 - 2.3
Sonoma, US 101	NB	-	-	1,258 - 1,283	1.8 - 1.8
EXPRESSWAYS					
Lawrence Expressway	SB	194	2.4	203	1.1
Montague Expressway	EB	0	0.0	0	0.0
Central Expressway	EB	60	0.2	60	0.2
San Tomas Expressway	SB	130	1.9	150	2.3

Notes:
1. Forecasts of future HOV lane use do not include possible lane violations. The lower end of the range for freeway HOV lanes represents the share of eligible vehicles using the lane as predicted by MTC's regional travel model. The high end of the range assumes that all eligible vehicles use the HOV lane. Expressway HOV lane volumes were forecasted by CCS Planning and Engineering Inc. using the Santa Clara CMA 2025 travel model and no range was presented. There were also no estimates of speed on expressway HOV lanes.
2. Operates peak direction only.

Source: DKS Associates

All but two of the 11 existing freeway HOV segments carry 800 or more eligible vehicles per hour (Caltrans' minimum threshold for use) in the peak direction in the a.m. peak hour Only SR 4 in Contra Costa County and the segment of US 101 in San Mateo County fell short of this level of use in the peak direction. The future-year forecasts indicate that, over time, all of the existing and planned HOV lane segments will achieve this minimum threshold for the peak direction. Three HOV lane corridors in Santa Clara County currently carry the highest volume of HOV-eligible vehicles: US 101, SR 85 and I-280.

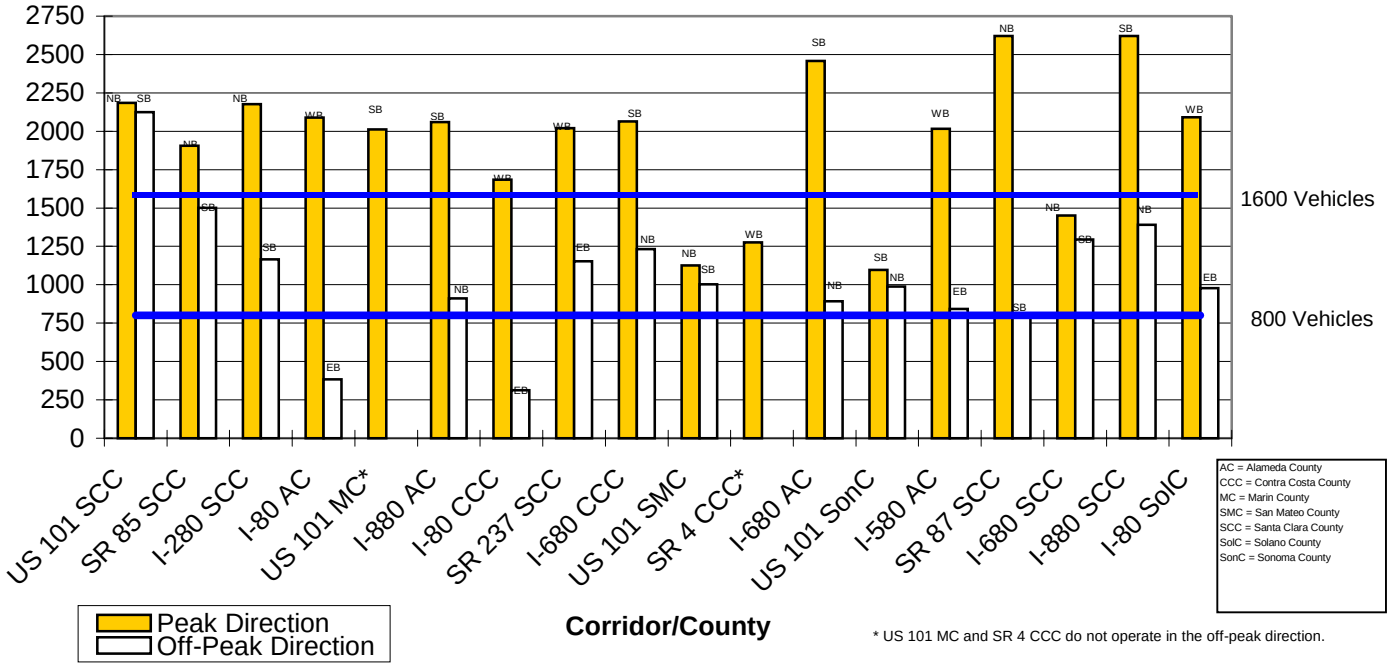
In the off-peak directions, three of the corridors carried at least 800 eligible vehicles in 2001 : US 101, SR 85 and SR 237, all in Santa Clara County. By 2025, all but three off-peak direction HOV lanes are expected to carry at least 800 eligible vehicles. Existing vehicular volumes in the HOV lane in the off-peak direction range from 119 to 2,044 eligible vehicles in the a.m. peak hour. The I-80 corridors in Alameda and Contra Costa Counties had the lowest off-peak direction volumes, with each under 150. The rest of the corridors had at least 600 eligible vehicles in the HOV lane in the off-peak direction in the a.m. peak hour.

A future concern about HOV lane use is the possibility that segments of the HOV lane system will attract more eligible HOV vehicles than can be accommodated by the lane thus jeopardizing the travel-time advantage provided by the lane. Because of the mix of vehicles in an HOV lane - passenger cars, motorcycles, vans and buses (and since new legislation – alternative fueled vehicles) - and because of the need for vehicles to weave into and out of the lanes, the practical vehicle capacity of an HOV lane is usually considered to be less than that of a mixed-flow lane. Caltrans and MTC generally use a standard of 1,600 vehicles/hour as the capacity of an HOV lane. Above this level, there is likely to be deterioration of the HOV lane speed. In 2001, the three highest volume freeway corridors in Santa Clara County exceeded this level of usage. Between 2010 and 2025, 12 corridors are expected to exceed this level, of which seven are existing facilities (as indicated in Table 2 and in Figures 4 and 5) and five are new corridors. Only six corridors are expected to have a.m. peak hour HOV lane vehicle volumes under 1,600.

HOV Lane Person Trips

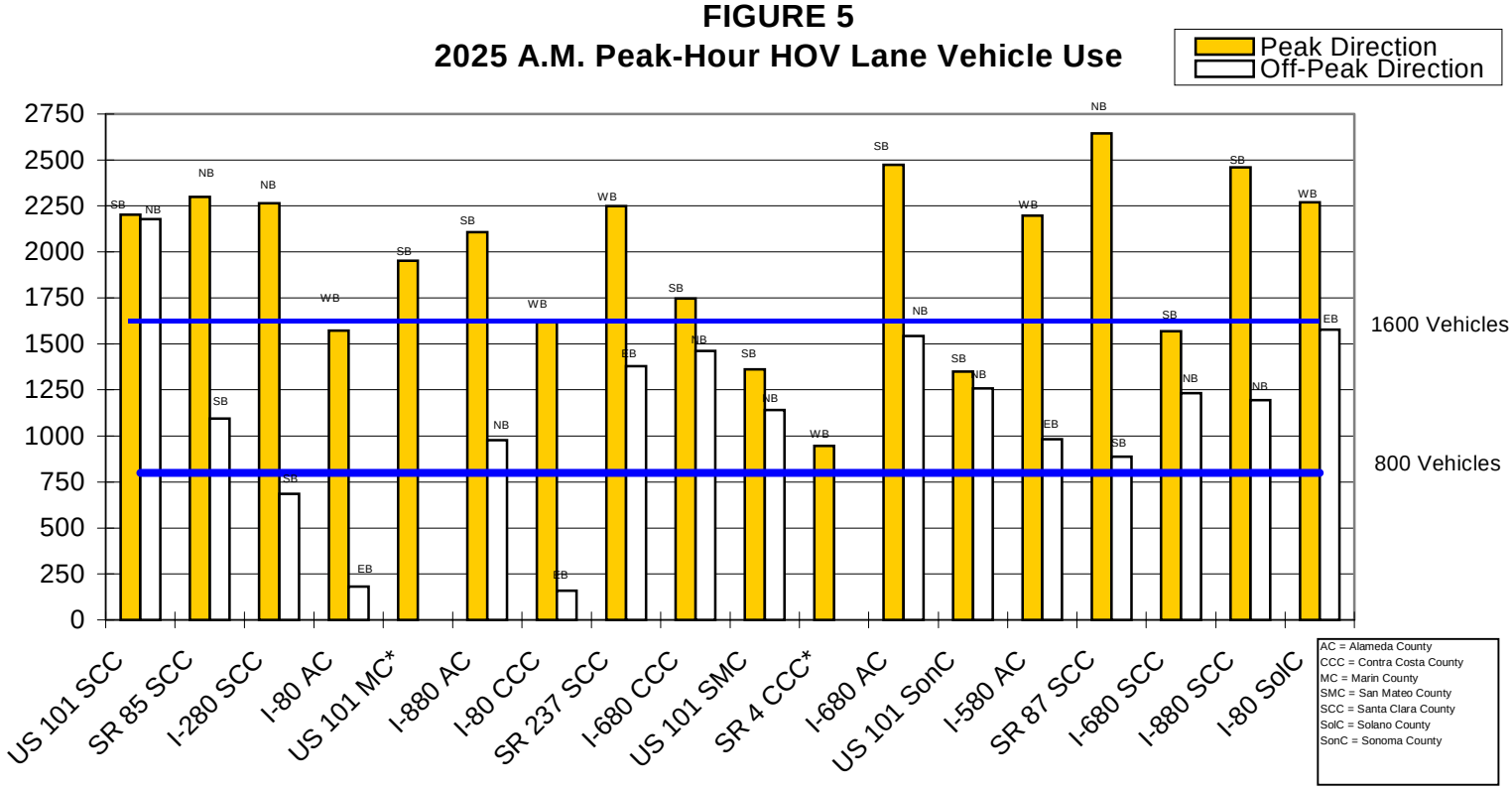
An assessment of the number of people moved in the HOV lanes in an average a.m. peak hour indicates that the highest volumes of people moved are on the two segments of I-80 where the occupancy requirement is 3+. As indicated in Figure 6, these two HOV segments and one segment on US 101 in Santa Clara County move more than 4,500 people per hour in the peak direction in the a.m. peak hour. The HOV corridors are plotted in the same order as in the previous two figures where they are ranked by HOV vehicles carried in the a.m. peak hour. Of the 11 existing freeway HOV segments, 10 are carrying more than 1,800 people per hour in the peak direction. By 2025, 14 out of 18 segments will carry at least 4,500 people per hour if all lanes continue to have 2+ occupancy requirements (see Figure 7). In the off-peak directions, four corridors carried more than 1,800 in 2001 and seven are expected to in 2025.

FIGURE 4
2010 A.M. Peak-Hour HOV Lane Vehicle Use (No Change to HOV Requirement)



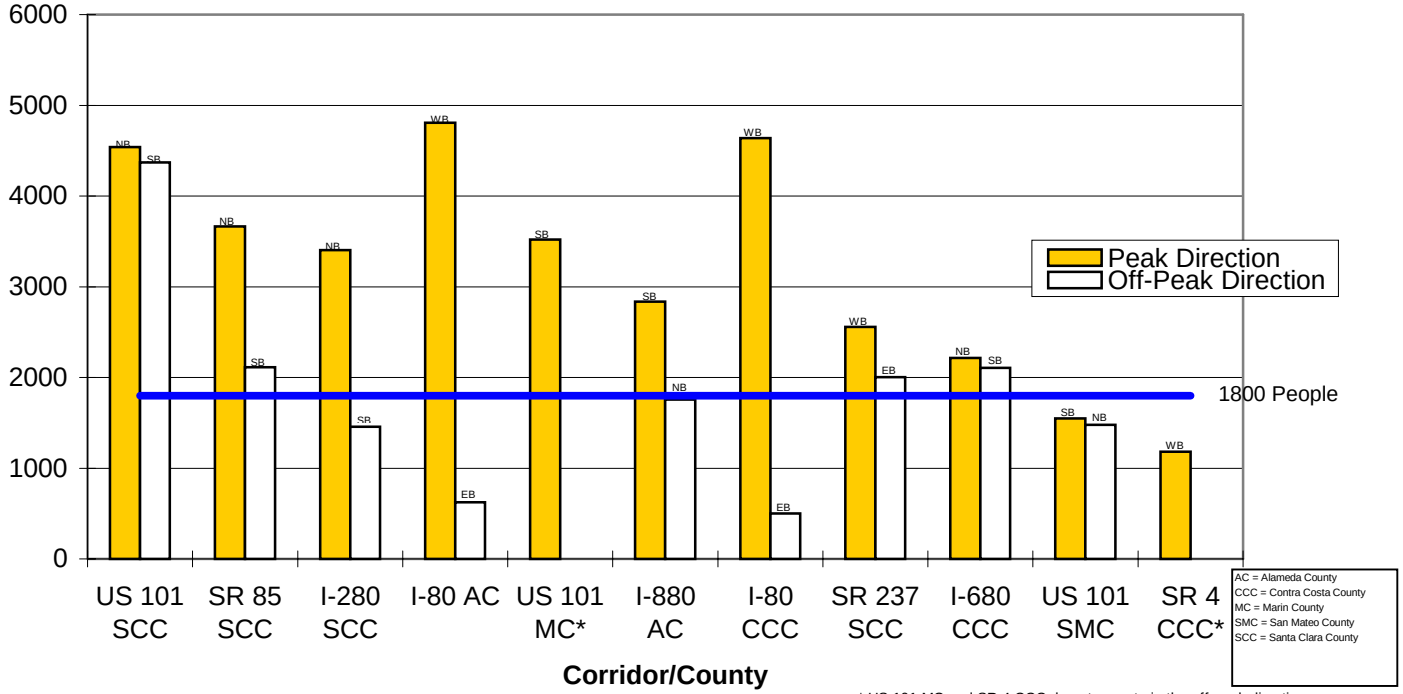
* US 101 MC and SR 4 CCC do not operate in the off-peak direction.

FIGURE 5
2025 A.M. Peak-Hour HOV Lane Vehicle Use



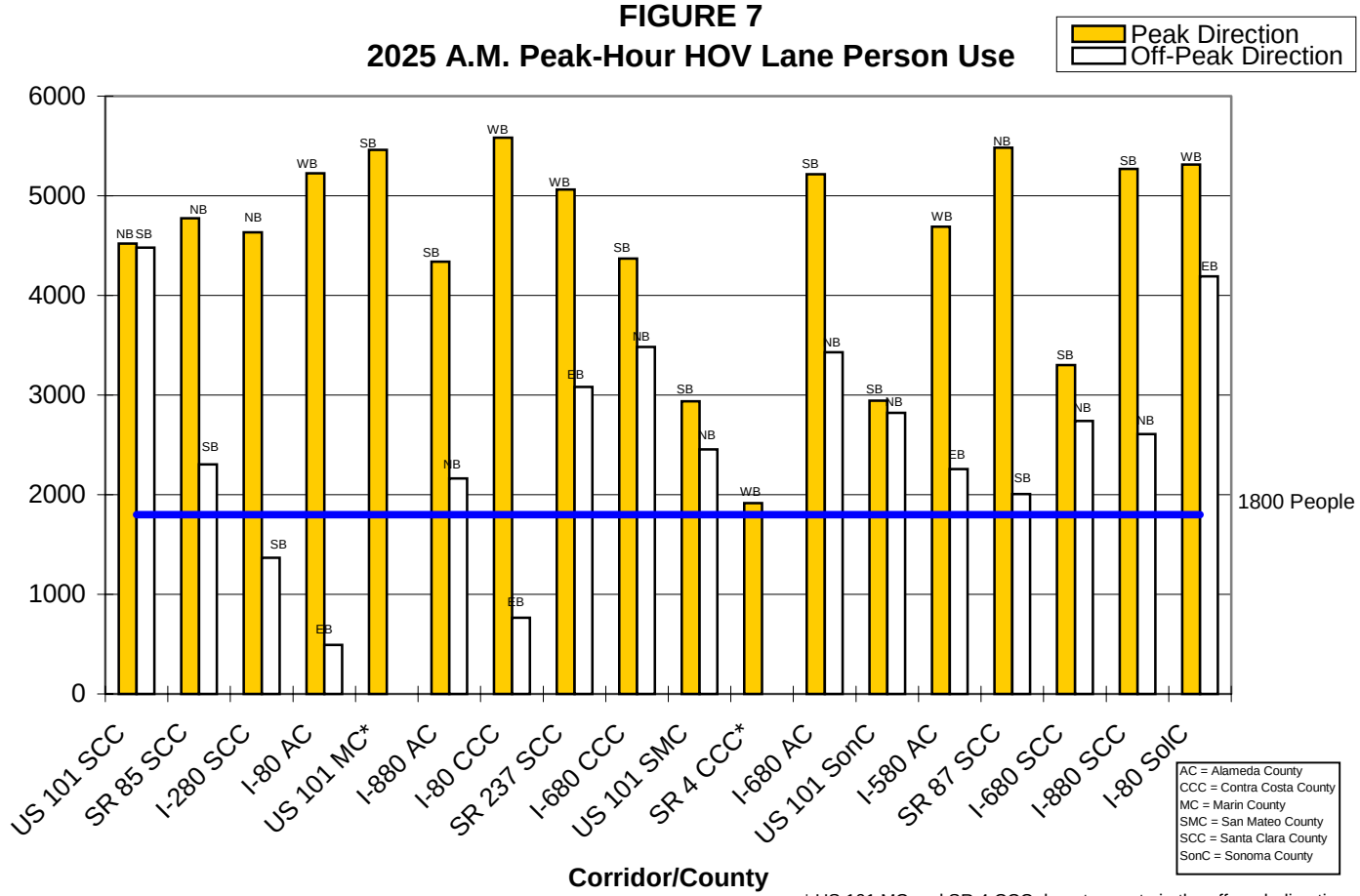
* US 101 MC and SR 4 CCC do not operate in the off-peak direction.

FIGURE 6
2001 A.M. Peak-Hour HOV Lane Person Use



* US 101 MC and SR 4 CCC do not operate in the off-peak direction.

FIGURE 7
2025 A.M. Peak-Hour HOV Lane Person Use

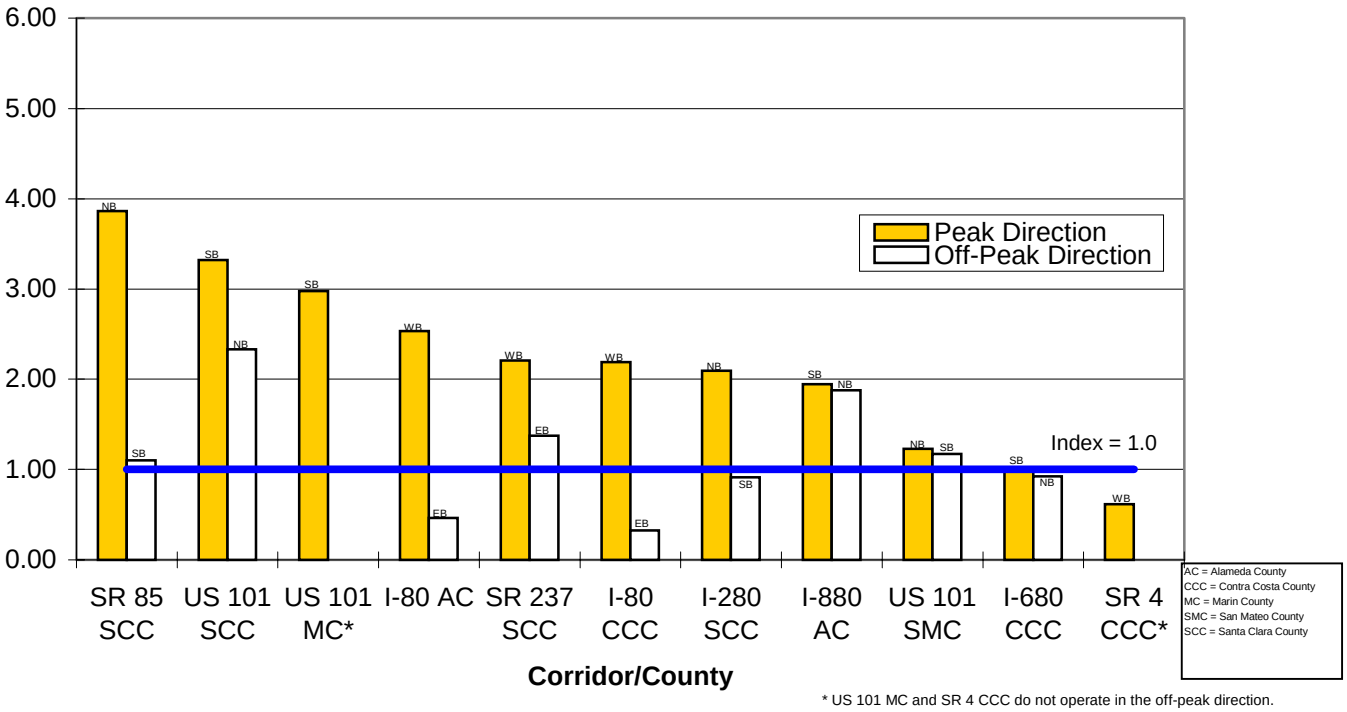


* US 101 MC and SR 4 CCC do not operate in the off-peak direction.

HOV Lane Productivity

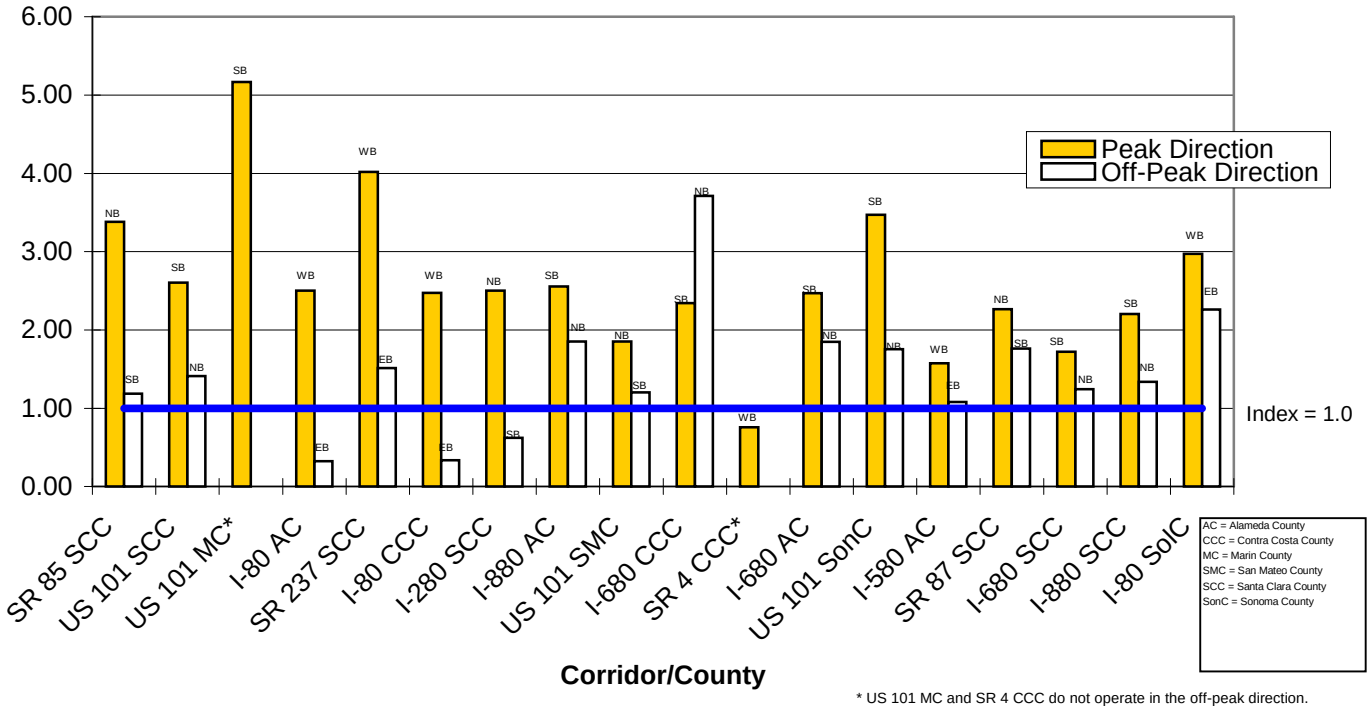
The value of the HOV lane system is demonstrated by an evaluation of how well the HOV lane segments perform in carrying people when compared to the mixed-flow lanes on the same freeway segments. In 2001, all of the 11 freeway HOV lane segments studied except one (Contra Costa SR 4) achieved an HOV lane productivity of 1.0 or better as indicated in Figure 8 (HOV lane productivity is measured as the ratio of people per lane per hour in the HOV lane to the average number of people per lane per hour in the adjacent mixed-flow lanes). Seven of the segments had productivity indices of 2.0 or better, indicating that they were carrying more than twice the number of people per lane as the mixed-flow lanes. SR 85 in Santa Clara had the highest productivity, at 3.9. By 2025, all of the existing and planned HOV lanes are expected to have productivities of greater than 1.0 except SR 4 in Contra Costa County (see Figure 9). In the off-peak direction, five corridors achieved a productivity of 1.0 or better in 2001. Seven are expected to in 2025.

FIGURE 8
2001 Productivity Index



* US 101 MC and SR 4 CCC do not operate in the off-peak direction.

FIGURE 9
2025 Productivity Index



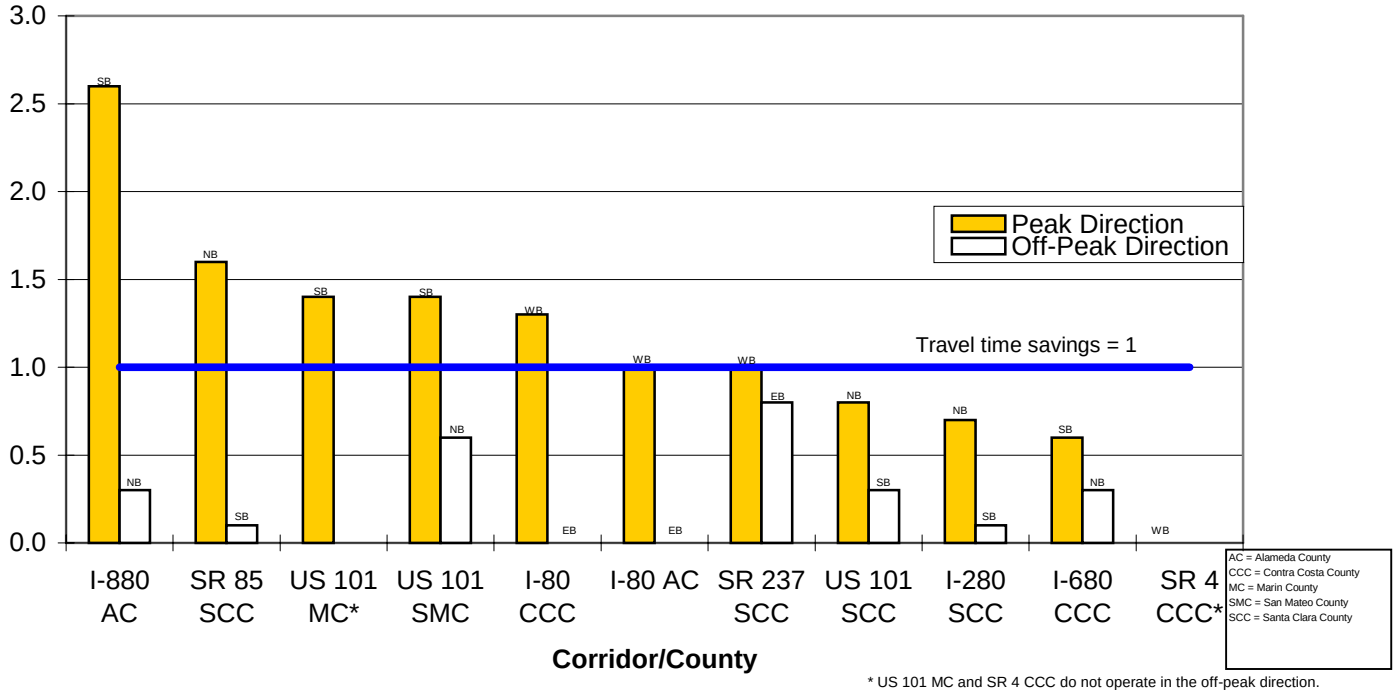
* US 101 MC and SR 4 CCC do not operate in the off-peak direction.

HOV Travel-Time Savings

The primary purpose of an HOV lane is to give a travel-time advantage to higher-occupancy vehicles and in doing so, induce more people to shift from traveling alone to carpooling, vanpooling and using express bus services that use the HOV lanes. A frequently used goal for HOV planning nationally is a travel-time savings of at least one minute per mile of HOV lane. This could be achieved on a 10-mile segment by a speed in the HOV lane of 60 miles per hour and a speed in the mixed-flow lane of 30 miles per hour, for example. As indicated in Figure 10, where the HOV lane corridors are ranked by travel-time savings per mile, six of the 11 existing HOV lane segments produce this level of savings in the peak direction, and four others produce savings of over 0.5 minutes per mile. The HOV lane segment on SR 4 in Contra Costa County demonstrated no discernable travel-time savings, which may provide the explanation for the corridor's weak overall performance. None of the corridors achieve a time savings of one minute per mile in the off-peak direction and only two achieve savings of 0.5 minutes per mile.

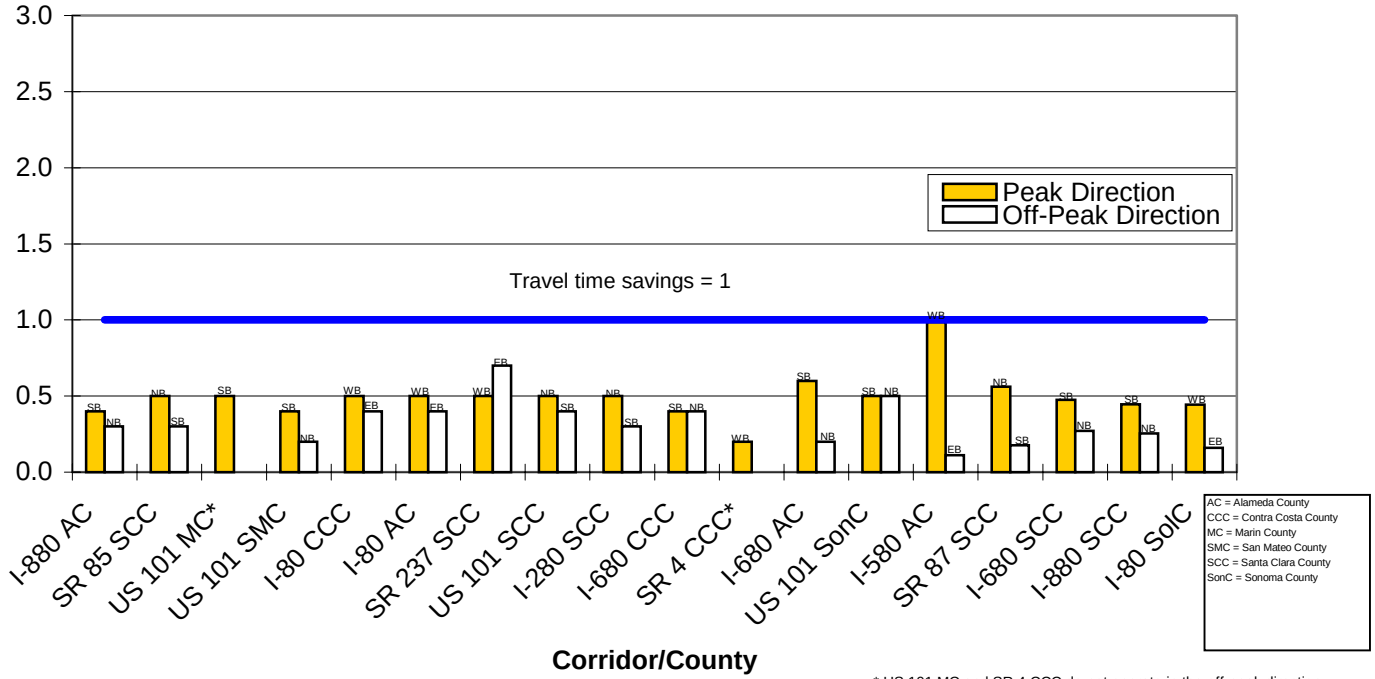
By 2025, HOV lane volumes are expected to grow (see Figure 5) to the point that many HOV lanes will be congested and provide little or no travel time savings over adjacent mixed-flow lanes. Figure 11 shows that only I-580 HOV lanes will meet the minimum time savings threshold due to congested HOV lane conditions in the peak direction with current vehicle occupancy requirements; the low travel time savings in the off-peak direction is primarily due to relatively uncongested conditions in both the HOV lanes and the mixed flow-lanes.

FIGURE 10
2001 Travel Time Savings (minutes/mile)



* US 101 MC and SR 4 CCC do not operate in the off-peak direction.

FIGURE 11
2025 Travel Time Savings (minutes/mile)



* US 101 MC and SR 4 CCC do not operate in the off-peak direction.

5 RECOMMENDATIONS FOR HOV LANE SYSTEM IMPROVEMENTS AND OPERATIONAL CHANGES

In addition to the infrastructure improvements identified in this report, a number of operational changes were considered and recommendations made. They are described in the sections that follow. Except where noted, the recommendations for operational changes are based on analysis of the HOV lane system performance (existing and predicted future) in the peak direction and during the a.m. peak period.

Hours of Operation

Bay Area transportation agencies have chosen to adopt a policy of tailoring the hours of operation of HOV lanes to the travel patterns in each individual corridor. As a result, the hours of operation are not the same throughout the region, but instead vary from corridor to corridor. The policy also is to have HOV restrictions only during the peak commute periods and not 24 hours per day as in many other metropolitan areas. In two instances, Marin US 101 and Contra Costa SR 4, HOV lanes operate in the peak direction only. At present, this approach appears to work well. It provides the HOV lanes for use during congested periods of the day and provides supplemental capacity in the off-peak if it is needed. This helps to maintain public support and potentially improves the operation of the freeways during some off-peak periods when the mixed-flow lanes might get congested.

The differences in hours of operation between corridors do not seem to be causing confusion for motorists, nor did the California Highway Patrol (the agency with responsibility for enforcing the HOV restrictions) see the different hours of operation in various corridors as a problem.

As congestion continues to increase in the Bay Area and the length of the peak period expands on the region's freeways, the Bay Area should consider moving toward a consistent regionwide set of hours. This should probably correspond to the current maximum spread of 5:00 a.m. to 10:00 a.m. and 3:00 p.m. to 7 p.m. Although congestion may occur outside of these peak periods in some corridors, the effectiveness of HOV lanes in producing a shift in mode to carpooling, vanpooling or transit is primarily an issue for commute trips. Having HOV lane restrictions in the off-peak period may provide HOVs with a travel-time advantage but would be less likely to produce a mode shift than the peak-period restrictions. There is no evidence that the Bay Area would benefit from 24-hour HOV lane restrictions that are common in Southern California or other parts of the U.S.

An analysis of peak-period HOV lane use in the off-peak directions indicates that the I-80 segments between the Carquinez and Bay bridges would be the only appropriate segments to consider for converting to mixed-flow lanes. These segments did not have an HOV vehicle volume-to-capacity (V/C) ratio higher than 0.27 in either the a.m. or p.m. off-peak direction. In each case there were less than 300 eligible vehicles in the HOV lane. Mixed-flow lanes in these segments had V/C ratios between 0.51 and 0.71, indicating mostly uncongested conditions. The I-80 HOV lanes therefore are providing little if any travel time savings for the small number of HOVs using the facility in the off-peak direction. All of the other HOV lane corridors that had HOV lanes in effect in both directions had HOV lane V/C ratios of 0.5 or higher (at least 800 vehicles), suggesting that the peak direction

are not all that clear. The other corridors are also fairly balanced flow corridors: Alameda I-880, Contra Costa I-680, Santa Clara Santa Clara 85, Santa Clara SR 237, Santa Clara I-280 Santa Clara US 101 and San Mateo US 101. The 2025 forecast suggests the same patterns: I-80 looks like a reasonable candidate for conversion of off-peak direction HOV lanes to mixed-flow lanes, but all of the others have HOV V/C ratios over 0.5 and more than 800 eligible HOVs in the off-peak direction Caltrans, CHP and MTC will continue to monitor HOV lane use in this corridor.

Based on the review of the 2001 data and the 2025 forecast, it is recommended that SR 4 in Contra Costa County and the four expressways in Santa Clara County be monitored by Caltrans and the Santa Clara County Roads Department to see if the HOV lane productivity increases. Santa Clara County is currently conducting an assessment of the expressway HOV lanes as part of an overall assessment of the county roadway system. Preliminary recommendations include designation of HOV segments on Montague and Lawrence Expressways. More HOV lane mileage is already programmed for SR 4 and this may provide the critical threshold of travel-time savings to attract more trips to the lane. If these HOV lanes do not increase in productivity over time, further analysis by Caltrans and MTC will be necessary to determine whether conversion to mixed-flow lanes. When conversion to mixed-flow is considered, a thorough analysis of the extent of express bus use and ridership in the HOV lane should be included in the evaluation. Consideration should also be given to creation of a High Occupancy Toll (HOT) lane to make the most effective use of the excess capacity while maintaining the HOV lane.

Occupancy Requirement

The most recent performance data (2001) for all existing freeway and expressway HOV lanes were examined to determine whether all of the facilities were achieving a high enough productivity under existing occupancy requirements. Facilities with a lane productivity of greater than 1.0 are considered to be sufficiently productive because the HOV facility is carrying more people per lane per hour than the average of the adjacent mixed-flow lanes. Almost all of the freeway corridors had productivity levels of 1.0 or greater in 2001, the exception being SR 4 in Contra Costa County with a westbound a.m. productivity level of 0.6.

The lane productivity for all of the existing HOV corridors also increased in the 2025 forecasts. The 2025 productivity estimates ranged from a low of about 1.0 (a range of 0.8 to 1.2) on SR 4 in Contra Costa County to over 5.0 on US 101 in Marin County (a range of 5.2 to 5.3). The data suggest that the Bay Area's freeway HOV system is very productive in moving people. The four expressway HOV lanes in Santa Clara County all had productivity levels of less than 1.0. In the 2025 forecast, the Lawrence and San Tomas Expressways approach a productivity level of 1.0, but the Montague and Central Expressways do not.

Current HOV lane volumes indicate that there is not need to consider changing HOV lane occupancy requirements at this time. However, by 2010, seven corridors are projected to have HOV lane volumes that will be near or exceed the practical capacity of 1,600 vehicles per hour; by 2025, 15 out of 18 freeway corridors will have HOV lane volumes that exceed HOV lane capacity.

Because of high forecasted use of the freeway HOV lanes between 2010 and 2025, the Bay Area should consider strategies to ensure the HOV lanes remain relatively congestion free and continue to provide travel time savings, including:

1. Improve overall corridor performance – Strategies would include: expanding express bus service, expanding CHP enforcement, adding auxiliary lanes to remove key bottlenecks and expanding use of ramp metering.
2. Increase HOV lane vehicle occupancy – No freeway segments currently warrant a change in occupancy requirement. Over the longer-term, increasing the HOV vehicle occupancy requirement would reduce HOV lane volumes and restore travel time savings. Forecasts for 2010 indicated that by that date 14 out of 18 freeway corridors would have at least 800 HOV eligible vehicles in the peak direction in the a.m. peak hour with the 3+ occupancy requirement. An increase in the HOV vehicle occupancy requirement would likely generate some public concern, but could be phased to correspond to individual corridor changes in the monitored HOV lane and mixed-flow lane volumes and travel-times.
3. Increase vehicle occupancy but charge for 2+ carpool use – This option is similar to #2, but a limited number of registered 2+ carpools could be allowed to use HOV lanes for a fee (see Section 7 of this report for more discussion of this concept). A similar program is currently operated on I-10 in Houston, Texas (Katy QuickRide program).

The Bay Area is not likely be able to implement a level of express bus service to warrant bus-only lanes on any part of the HOV lane system over the next 25 years based on 2001 RTP investments. Although the projected number of express buses would not warrant any exclusive freeway lanes, service would be improved if the HOV lane occupancy requirement were raised.

Consideration of Spot Use of Shoulders for Temporary HOV or Bus-Only Lanes

The temporary use of shoulders was analyzed as an interim step for all freeway segments where future HOV lane segments are proposed. In addition, the use of shoulders was analyzed for segments where the addition of an HOV lane seemed desirable from a system perspective but where the available right of way would prevent the addition of another lane. This included Alameda I-880 from 98th Avenue north to the Bay Bridge approach and San Mateo US 101 from Millbrae Avenue north to I-280.

The analysis of all of the freeway corridors for possible shoulder use indicated that in almost every case there was not sufficient shoulder width on a continuous basis to safely allow for use of the shoulder. Almost all of the corridors analyzed had bottleneck points in one or both directions where there was not at least 16 feet of shoulder width between the two sides of the freeway lanes, which is considered to be the minimum to allow for a 12-foot lane and leave a 2-foot shoulder on both sides. Only the following locations appeared to have the minimum width required to consider the use of the shoulders and to provide critical gap closures for express bus streams.:

- Alameda I-880 – northbound from just north of I-980 to the existing HOV lane on the approach to the Bay Bridge

- Alameda I-580 – west of I-680 in both directions
- Alameda I-680 – northbound from just north of SR 84 through the I-580/I-680 interchange to the existing HOV lane. Southbound will not work.

It is recommended that further consideration be given to the possible temporary use of shoulders for HOVs on these segments as a way to close gaps in the HOV lane system or to provide an interim HOV priority until a permanent HOV lane can be constructed. Caltrans does not support using shoulders for bus-only lanes that are contiguous to existing part-time HOV lanes due to potential confusion between the buses and HOVs. Shoulder bus-only lanes are used in other parts of the country, but these are in operation 24 hours per day.

While the use of shoulders for HOV use might be justifiable on a temporary basis as a way to significantly improve overall mobility and increase vehicle occupancy, it is suggested only as a temporary measure because using a shoulder as a traffic lane also eliminates the space that is used for emergency stops, disabled vehicles and for traffic enforcement.

Further, Bay Area freeway shoulders are generally not designed to carry daily traffic, especially heavy-duty vehicles such as buses. Most Bay Area freeway shoulders are eight feet or less in width and constructed with minimal paving and substructure. Use of the shoulder without substantial reconstruction of the shoulders would result in an uneven surface for newly created lanes (potentially on both the inside and outside lane if shoulder width has to be taken from both sides.) Without substantial reconstruction, use of the shoulders would also result in rapid deterioration of the shoulder and uneven wear in the lanes where shoulders are used.

Caltrans, the CHP and MTC will conduct a more thorough assessment of candidate shoulder segments that could be used to extend or close HOV lane gaps.

6 HOV LANE ENFORCEMENT

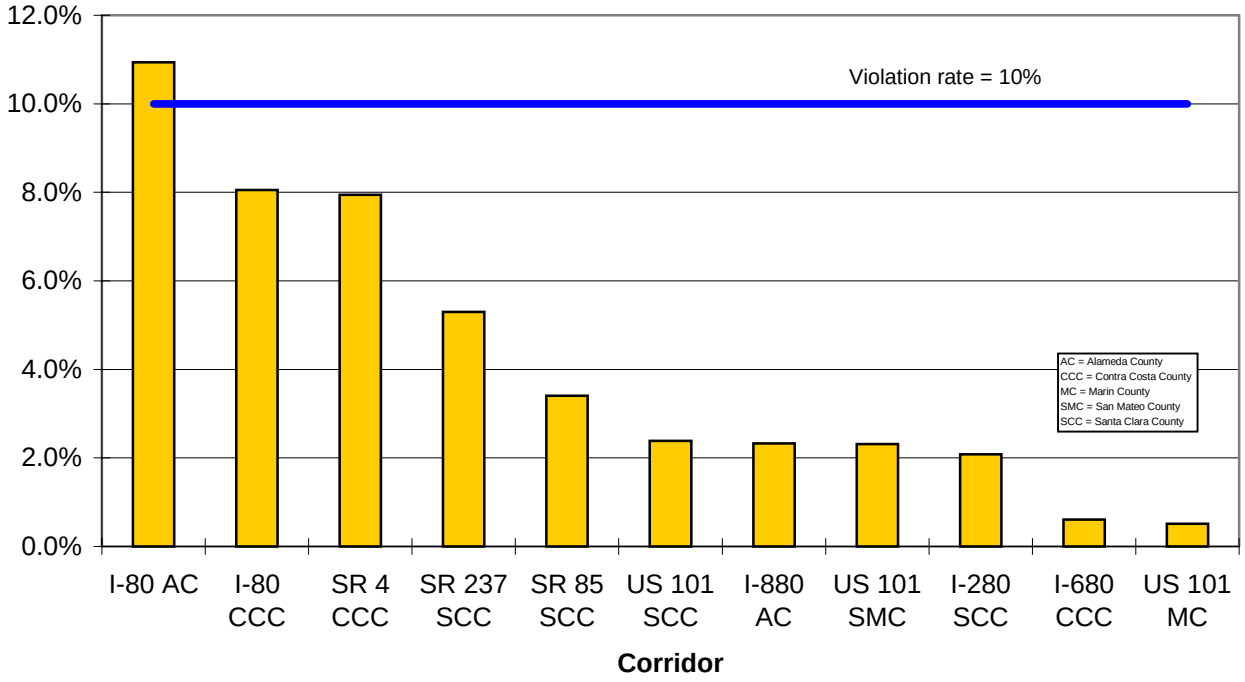
The CHP operates with the philosophy that the most effective deterrent to HOV lane violations is for CHP officers to be visible on the roadways watching for violators and issuing citations. CHP officers enforce HOV restrictions as part of their normal patrol of the roadways for safety violations and criminal behavior. This enforcement activity also is supplemented by targeted enforcement where patrol officers are sent out specifically to enforce HOV violations. The supplemental enforcement activity is made possible through overtime pay to patrol officers that is funded by Caltrans.

The distribution of enforcement resources throughout the Bay Area is based on several factors. These include the violation rates monitored by Caltrans, as well as congestion patterns that might benefit from increased enforcement. The distribution is evaluated periodically throughout the year and is often modified based upon input from CHP area commanders.

A review of the history of HOV lane violation rates in the Bay Area indicates that there has been dramatic improvement in HOV lane compliance. The review also indicates that Bay Area freeways are almost all within the national guidance standards for acceptable violation rates. Nationally, a violation rate of less than 10 percent is considered good. As indicated in Figure 12, where the corridors are ranked by violation rate, only I-80 in Alameda County at the approach to the Bay Bridge Toll plaza had a violation rate that

exceeded 10 percent. Violation rates for the peak direction were generally in the range of 2 percent to 8 percent

FIGURE 12
2001 Violation Rates



Based on the analysis conducted in this task, the following actions are recommended to potentially improve the efficiency and effectiveness of HOV lane enforcement in the Bay Area:

1. Continue monitoring HOV lane violation rates and distributing targeted HOV enforcement resources where appropriate. HOV lane violations not only reduce the effectiveness of the HOV lanes in offering a travel-time advantage to carpools, vanpools and express bus use; the lane violations also threaten the public's support of the HOV lane system
2. Enforcement areas should be constructed in the medians of freeways at a spacing of two to three miles wherever 14-foot median shoulders are not available and the median width will allow construction of the enforcement areas.
3. A method for providing consistent and regular funding of HOV lane enforcement should be sought to allow targeted enforcement to occur without incurring the additional overtime cost for officers. Consideration should be given to earmarking revenue from HOV lane fines for enforcement.
4. Bay Area legislators should seek to pass legislation to allow the penalty for HOV lane violation to increase with multiple offenses.

7 CONSIDERATION OF HIGH-OCCUPANCY-TOLL (HOT) LANES

Several in-depth analyses have been conducted on congestion pricing concepts in the Bay Area. These analyses have focused on assessment of the feasibility and desirability of implementing congestion-based tolls and the potential for HOV lane buy-in by drivers of vehicles not otherwise eligible for the HOV lane; those tolled facilities are known as HOT lanes. These analyses have examined congestion pricing concepts on the Bay Bridge, US 101 in Sonoma County, I-880 in Alameda County and I-680 in Alameda County. These analyses have led to the conclusion that the best opportunities for implementation of congestion pricing in the Bay Area are on the Bay Bridge or the other toll bridges in the region. The toll bridges already have HOV by-pass lanes and the infrastructure necessary to collect tolls. The studies for US 101 in Sonoma and Marin counties and I-680 in Alameda County both found the concept to be technically and financially feasible and worthy of further public discussion. Additional assessment of the operational requirements for implementation is still under way for I-680.

For HOV applications, HOT lanes could be employed to:

1. Manage the total number of vehicles in the HOV lane by charging all but the 3+ vehicles.
2. Sell excess capacity in peak or off-peak directions to optimize overall freeway performance by allowing SOVs into lanes.

Managing HOV lane demand

In order to manage entry into HOV lane and to preserve travel time savings, given projected use by 2+ vehicles, HOV carpool use would need to be rationed among eligible vehicles.

The previous assessment efforts have clearly indicated that any HOT lane application on most existing Bay Area HOV lanes would almost certainly have to be one that relies on a low level of infrastructure and lane separation. Most existing Bay Area HOV lanes and freeways do not have the lane separation or the median space to implement the limited-entry/exit systems that are found in other areas of the country. A low-cost Bay Areawide application on existing HOV lanes could rely on a monthly subscription system that allows use of a prominently displayed color-coded sticker on non-carpool vehicles to determine eligibility. This type of system was successfully used in the first phase of the I-15 HOT lane in San Diego County. Vehicles using the lanes would be charged a monthly fee and would relinquish the sticker for other users if they did not use the lane.

Public opinion can be a significant issue in the implementation of HOT lanes. Many travelers think that the lanes will provide an advantage to higher-income travelers and is therefore not equitable. The experience with HOT lanes in other parts of the country suggests that the lanes are regularly used by a large percentage of medium-income commuters, contrary to the notion that these are exclusively used by higher-income commuters. In addition, the implementation of a HOT lane can be used as a way to sustain a viable HOV lane or to achieve a shift to a 3+ occupancy requirement that provides travel-time advantages to HOV eligible vehicles, which do not have to pay the toll.

Selling Excess Capacity in HOV Lanes

With the current 2+ occupancy requirement on all of the freeway lanes in the Bay Area except I-80, there is only potentially available capacity to be sold on four existing HOV lane corridors. The corridors and the 2001 and 2010 HOV lane peak hour/peak direction volumes are as follows:

Corridor	2001 HOV Volume	2010 Volume
• CC SR 4	568	1,200
• CC I-680	821	1,100
• SM US 101	698	1,100
• SON US 101	N/A	1,000

To determine whether there would be available capacity to be sold with a 3+ occupancy requirement, a travel forecast was prepared for 2010 with all HOV lanes designated as being 3+. Of the 18 corridors tested, eight had HOV volumes of less than 1,200 vehicles per hour in the peak period when all eligible HOV vehicles are assumed to be in the HOV lane. These segments were evaluated, with additional consideration given to the length of the HOV lane as planned in each corridor and the expected congestion in the mixed-flow lanes. Based on these criteria, six corridors seemed to be most promising for consideration for long-term congestion pricing:

- Alameda I-580
- Contra Costa SR 4
- Contra Costa I-680
- Santa Clara SR 85
- San Mateo US 101
- Sonoma US 101

The segments of US 101 in Sonoma County and I-680 in Alameda County that have been considered for HOT lanes have new HOV lanes; current information is not available, but the initial demand forecast suggests that excess capacity will be available.

If more HOV lanes are converted from 2+ to 3+ as the HOV lanes reach capacity, there may be a period of time during which there is considerable excess capacity in the HOV lane. As the demand for 3+ carpools and vanpools builds, there may be an opportunity for implementation of HOT lane concepts in which two-occupant and possible single-occupant vehicles are allowed into the HOV lanes for a toll. Providing this opportunity for low-occupant-vehicle (LOV) buy-in could raise revenue for system maintenance or improvement and could maximize the efficiency of the system by improving the flow in the mixed-flow lanes. The amount of the toll could be set to achieve a shifting of some LOVs to the HOV lane but keeping the number of LOVs shifting to a level that would not impact the operating speed of the HOV lane.

I-680 Sunol Grade HOV Lanes – A Possible HOT Lane Demonstration Project

The Alameda County Congestion Management Agency is currently studying the operation and financial feasibility of implementing HOT lanes on the newly opened I-680 Sunol Grade HOV lanes. Initial results from the study indicate that the HOT lane concept is operationally feasible, with some improvements needed at the current HOV lane terminus near SR 237. Preliminary estimates indicate that revenues in excess of HOT lane operating

costs could be available for additional corridor transportation improvements. Consideration should be given to the opportunities for congestion pricing on these facilities plus intermediate-term opportunities on I-680 in Alameda County.

8 EXPRESS BUS RECOMMENDATIONS

The *2002 HOV Lane Master Plan Update* differs from previous HOV lane planning efforts in the Bay Area because it includes specific consideration of the integration of express bus services with the HOV lane system to ensure that the two systems are mutually consistent and supportive. Existing express bus routes were identified and new services have been proposed where the present or future HOV system would support additional service between high demand origins and destinations. Additional HOV –related facilities also to support the express bus service recommendations also have been identified. These include direct HOV lane access ramps, park-and-ride facilities and major in-line transit stations adjacent to the HOV lanes.

Express bus service "streams" have been defined that could use HOV lanes to move freely from one part of the region to another, especially in corridors without rail service, and generally serve long-distance regional peak period commute trips, and to a lesser extend, off-peak trips. When buses cannot easily enter and leave this stream, the usefulness of the stream for moving people is diminished. With faster express bus speeds, more riders per hour can be served and operating subsidy requirements can be lowered. The proposed express bus streams, illustrated in Figure 11, are as follows:

- Stream 1 (Gold) – Sonoma County to downtown San Francisco via US 101
- Stream 2 (Gray) – Marin County to Berkeley/Oakland via I-580 and I-80
- Stream 3 (Blue)– Solano/Napa counties to downtown San Francisco via I-80, the Carquinez Bridge and the Bay Bridge
- Stream 4 (Orange) – Solano/Contra Costa counties to Santa Clara County via I-680 and the Benicia Bridge
- Stream 5 (Maroon) – Tri-Valley to Berkeley/Emeryville via I-580, I-680 and SR 24
- Stream 6 (Green) – Tri-Valley to San Mateo County via I-580, I-238, I-880, SR 92 and the San Mateo Bridge
- Stream 7 (Purple) – East Contra Costa County/Tri-Valley to Santa Clara County via I-580, I-680, I-880, SR 84, SR 237, US 101 and the Dumbarton Bridge
- Stream 8 (Red) – Southern Santa Clara County to San Francisco via SR 85 and US 101
- Stream 9 (Navy) – Hayward/Oakland to San Francisco via I-880 and the Bay Bridge

Express Bus Streams

DKS Associates

FIGURE 13

Although the streams proposed here are new in concept, they will augment and unify many on-going express bus initiatives and allocation of bus resources in the region. Not only do they offer improvements to productivity (through faster travel-times and resulting increases in ridership), but they provide a setting to consider new routes that are not typically contemplated. To augment existing services 12 new routes have been defined and 24 existing routes have been expanded, thereby more than doubling existing peak period regional express bus frequency.

The highest priorities for express bus system expansion (Priority 1) are in the following corridors:

- I-680 corridor in Contra Costa, Alameda and Santa Clara counties
- I-80 corridor in Solano, Contra Costa, Alameda and San Francisco counties
- US 101 in Sonoma and Marin Counties.

Express Bus System Characteristics

Listed below are some express bus system characteristics for Priority 1 and 2 improvements:

	# of New Buses	# of New Bus Trips	New Bus Revenue Miles
Priority 1	110	253	1,917
Priority 2	28	64	479
Total	138	317	2,396

Projected Express Bus Ridership

The MTC forecast models evaluated an expanded HOV lane system with and without the recommended express bus system in place. The results are as follows:

Alternative	Average Weekday Regional Transit Trips (yr. 2010)	Increase Transit Trips over Base Case	Increase - #2 to #3
1) Base Case – 2003 TIP	1,436,000		
2) 2001 RTP plus Priority 1 improvements	1,455,000	19,000 (1.3%)	
3) 2001 RTP plus Priority 1 improvements and expanded express bus system	1,470,000	34,000 (2.4%)	15,000 (1%)

As seen above, average weekday regional transit trips in 2010 are projected to total 1,436,000 riders with programmed 2003 TIP HOV lanes in operation. Regional transit trips are projected to increase by an additional 19,000 riders (1.3 percent) if HOV lanes included in the 2001 RTP and those recommended as Priority 1 improvements in this plan (see Section 9) are added to the 2003 TIP system. Adding the recommended express bus system in this plan to the expanded RTP/Priority 1 HOV lane system increases regional

transit ridership by 34,000 riders (2.4 percent) compared to the 2003 TIP HOV lane base case.

Direct Access Ramps

The existing and proposed new express bus service can be supported by a variety of HOV lane system improvements that give priority to express buses, saving travel-time and costs. Direct access ramps that provide priority access to and egress from HOV lanes for express buses and other HOVs are proposed for eight locations at an estimated cost of $400 million to $500 million. The eight locations are as follows:

County	Corridor	Location/Limits
Alameda	I-80	Berkeley (Ashby Avenue)
Alameda	I-580/SR 24	Oakland (to the Bay Bridge HOV lane)
Contra Costa	I-80	Richmond Parkway (under construction)
Contra Costa	I-80	Cutting Blvd (under construction)
Contra Costa	I-680	San Ramon (Bollinger Canyon Road)
Marin	US 101	Larkspur (Sir Francis Drake Boulvard)
Santa Clara	I-680	Milpitas (Montague Expressway)
San Mateo	US 101	Millbrae Avenue

In addition, two types of express bus stations are proposed to facilitate the transfer of passengers from local buses or private vehicle to the HOV lane-bound express buses. Six major stations and 15 minor stations are proposed. The characteristics of each type of station are described below. The total estimated cost for the 21 new stations is $213 million.

Major Express Bus Station (Intermodal Center)

The express bus system is highly dependent on good local bus connections and adequate park-and-ride space. The major express bus station is intended to provide a place that major regional connections between express buses and other regional and local transit services can be made. These facilities are places where major transfers between buses would occur, resulting in a substantial number of vehicles laying over in the freeway median to allow riders to make connections. They are most appropriate where high volumes of regional rail service are provided (such as BART and Caltrain stations) or where several express bus streams converge.

The major stations would be located in the freeway median at interchanges where local bus stops and park and ride facilities can be located below the station. When these stations are created, freeways will need to be widened. Direct access to and from the station would be provided for express buses by using slip ramps to and from the HOV lane. The stations would include bus lane pull-outs for freeway/express buses with up to four buses that can meet at one time; room for 12 local/surface street buses/shuttles (six in each direction); pedestrian connections to surface street; bus shelters with real-time transit information, advance fare purchase machines, bicycle parking areas, lighting and benches for express buses and any local bus connection. An example of a major express bus station is provided in Figure 12.

FIGURE 14 Express bus transit station on the El Monte Freeway in Los Angeles

The supporting park-and-ride demand is generally anticipated to be between 300 to 800 park-and-ride spaces. These park-and-ride facilities are designed to serve many express buses going to several destinations. The high frequency of bus service and the resulting attractiveness of boarding buses here will create demand for additional spaces. Actual spaces demanded will depend on analysis of park-and-ride demand at these locations.

Major express bus stations are proposed at the following locations:

County	Corridor	Location/Limits
Alameda	I-580	Livermore (Airway Boulevard/Isabel Avenue)
Alameda	I-580	Livermore (Greenville/Vasco Road)
Alameda	I-580	Pleasanton (Dublin/Pleasanton BART)
Contra Costa	I-680	Pleasant Hill or Walnut Creek (BART)
Santa Clara	SR 85	Los Gatos (Winchester Boulevard/Vasona Junction)
Santa Clara	SR 85	Cupertino (DeAnza College/Stevens Creek Boulevard.)

Minor Express Bus Station

The minor bus station is intended to provide an interface between the express buses in HOV lanes and the local pedestrian and transit network, and a few buses and shuttles that are used to carry passengers to local destinations. While these facilities are intended to provide locations where local passengers can board or alight express buses, there also may be some opportunities to provide minor transfers between a small number of express buses, or between express buses and a few local buses that operate on a route that crosses on the local street at the express bus stop. The minor bus stations would be located off the freeway and would not require direct access to and from the HOV lane.

The park-and-ride need for these stations is anticipated to be up to 200 spaces per station, but not all stations would need parking. These park-and-ride facilities are designed to serve

express buses that stop on this route; not all express buses in a stream would stop at these locations.

Minor express bus stations are proposed at the following locations:

County	Corridor	Location/Limits
Alameda	SR 92	Hayward (Clawiter Road)
Alameda	SR 84	Newark (Newark Boulevard)
Contra Costa	I-680	Danville (Sycamore Valley Road)
Marin	US 101	Novato (Alameda del Prado/Smith Ranch Road)
Marin	US 101	Novato (Rowland Blvd.)
Santa Clara	US 101	Palo Alto (Oregon Expressway)
Santa Clara	SR 85	San Jose (Santa Teresa LRT/Cottle Light Rail Transit)
Santa Clara	SR 85	San Jose (Oakridge area/LRT connection)
Solano	I-80	Vallejo (Marine World area/SR 37)
Solano	I-680	Benicia (Lake Herman Road)
Sonoma	US 101	Rohnert Park (Rohnert Park Expressway)
Sonoma	US 101	Petaluma (Lakeville Road)
Alameda	I-680	Pleasanton (Bernal Road)
Santa Clara	SR 85	San Jose (Camden Avenue)
Santa Clara	SR 85	Saratoga (Saratoga Avenue)

In addition to the direct access ramps and the express bus stations, priority treatments also are recommended on select arterials to give buses priority in getting to and from the freeway. The priority treatment could range from transit priority in the signal system to bus-only arterial roadway lanes and transit stations in freeway medians.

The arterial corridors where priority bus treatments are already proposed or operating include the following:

County	Corridor	Location/Limits
Alameda	I-80	San Pablo Avenue and Telegraph Avenue
Alameda	I-880	International Boulevard
Santa Clara	US 101 and I-280	El Camino Real

Other corridors where bus priority treatments are recommended for further study are as follows:

County	Corridor	Arterial
Alameda	I-580	Vasco Road and MacArthur Boulevard
Contra Costa	I-680	Contra Costa Boulevard and Main Street
Santa Clara	SR 85	Monterey Highway
Santa Clara	I-280	Stevens Creek Boulevard
Santa Clara	I-680	Montague Expressway
San Mateo	US 101	El Camino Real
Solano	I-80	Curtola Parkway and Travis Boulevard

Some express bus routes could operate within the “streams” on these arterials as well. The resulting travel-time benefits would further reduce operating time and costs, attract more ridership and increase farebox recovery ratios.

Express Bus Costs

The cost (in millions of 2002 $) to implement the express bus system is as follows

Capital Costs	Priority 1	Priority 2	Total
Buses	$32 – $40	$8 - $10	$40 – 50
Major Stations	$114	$71	$185
Minor Stations	$23	$6	$29
Total Capital Cost	$169 - $177	$85 - $87	$254 - $264
Annual Bus Operating Cost	$12 - $20	$3 - $5	$15 - $25

9 RECOMMENDED HOV LANE SYSTEM INFRASTRUCTURE COSTS

Recommendations for future HOV lane system expansion and infrastructure improvements have been developed and cost estimates produced. The recommended improvements are intended as long-range improvements designed to be implemented over the next 20 to 30 years, to support the role of the HOV lane system and the express bus system in providing Bay Area mobility. They are contingent on identifying new funding. The recommendations are based on an analysis of existing (2001) system operating conditions and forecasted (2025) baseline conditions for the transportation system defined by the 2001 RTP.

Cost analysis was performed using the Caltrans Preliminary Cost Analysis Worksheet. Assumptions were made for available right of way based upon inspection of aerial photography. Unit construction costs were based on planning-level documentation. Utility relocations were included, but verification of utilities was not made. All structure construction was estimated to be on pile support foundations. Acquisition of additional right of way was quantified based on a broad per-square-foot average for the region. Widening of the freeway to accommodate the additional HOV lanes was tailored to meet Caltrans policies. There are locations where design exceptions will be required from the state. Environmental clearance and engineering were anticipated in the cost assessment. In addition to all of the known cost elements, a 30 percent contingency also is included in each cost estimate. All costs are stated in 2002 dollars.

The recommendations are presented in two groups: Priority I and Priority II. Those in Priority I are recommended for inclusion in the next RTP update, subject to funding availability, while those in Priority II are recommended for inclusion in a future RTP only if new funding sources beyond those currently assumed in the RTP can be identified for the improvements. Five types of improvements have been identified:

1. New HOV Lane Miles – These represent gap-closure projects as well as new facilities and extension of existing facilities.
2. Freeway-to-Freeway HOV Connections – Ramps directly connecting the HOV lanes on two or more intersecting freeways.
3. Direct HOV Lane Access Ramps – Entry and/or exit ramps providing direct HOV-only access to and from the HOV lane.

4. Major In-Line Freeway Express Bus Stations – Major intermodal stations in the freeway median where express buses can load and unload passengers without having to leave the freeway. The major stations also would include local bus loading bays and park-and-ride spaces on the local crossing streets adjacent to the station.
5. Minor Freeway Express Bus Stations – Minor stations would not be located in the freeway median but would be located adjacent to the freeway instead. Minor stations would have local bus service bays and park-and-ride spaces as well as priority lanes on the on- and off-ramps where that is appropriate.

In addition to these major improvements, additional park-and-ride sites and additional ramp priority should be pursued as opportunities permit, but specific locations have not been identified in this project.

The recommended Priority I improvements, which will cost roughly $706 million in 2002 dollars, are illustrated graphically in Figures 13 and 14:

- 71 new freeway HOV lane miles - $337 million
- one new freeway-to-freeway HOV connection - $34.8 million
- two new direct access ramp locations and two expansion locations - $196.9 million
- three new major freeway express bus stations - $114 million
- 12 new minor express bus stations - $22.9 million.

The recommended Priority II improvements, which will cost roughly $1.05 billion in 2002 dollars, are illustrated graphically in Figure 15 and 16:

- 87 new HOV lane miles - $469 million
- five new freeway-to-freeway HOV connections - $290 million
- four new direct access ramp locations - $215.4 million
- three new major freeway express bus stations - $70.6 million
- three new minor express bus stations - $5.7 million.

Priority 1 Recommended HOV Lane System Improvements

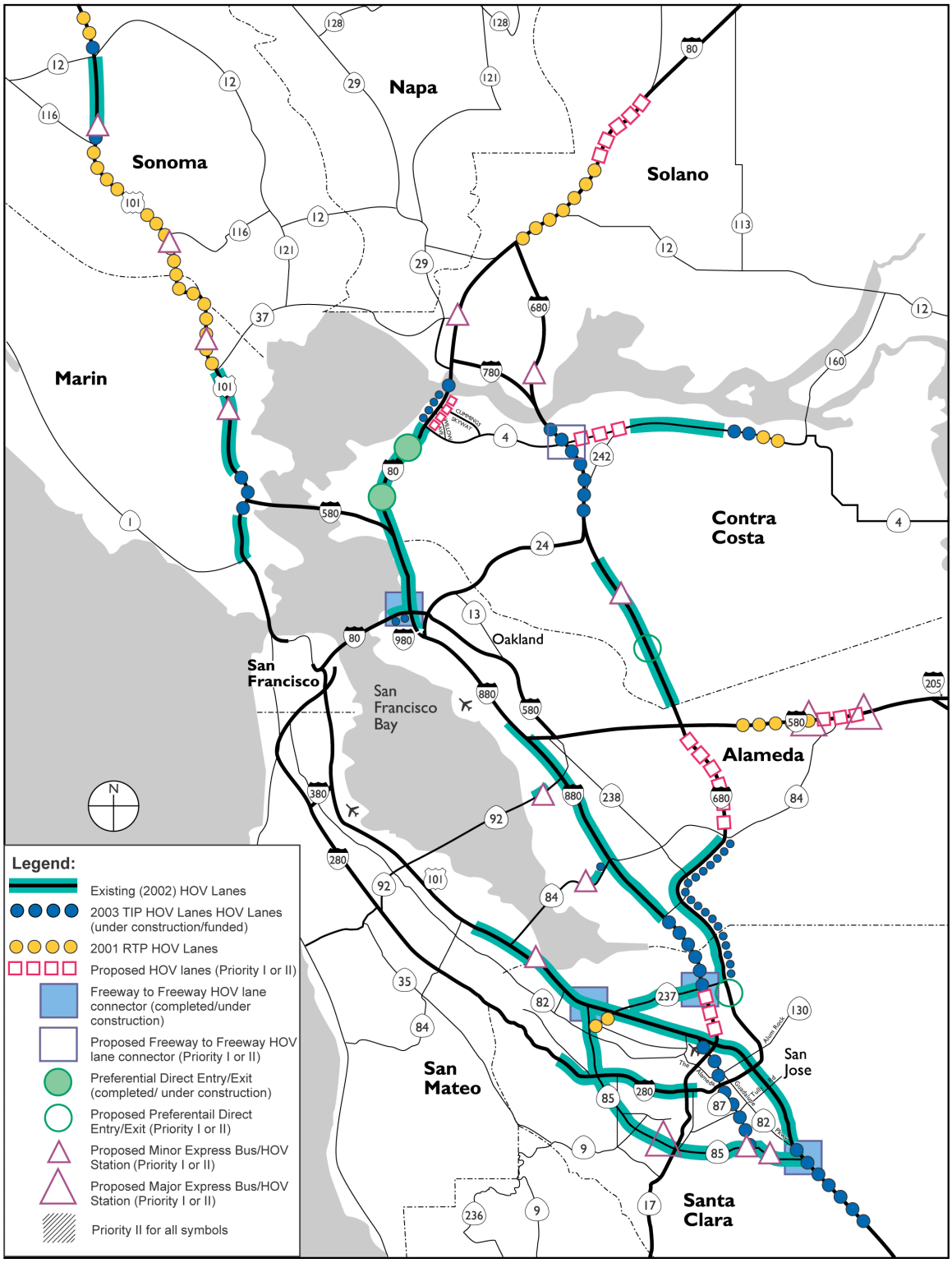


FIGURE 15

Priority 1 Recommended HOV Lane System Improvements: Santa Clara County

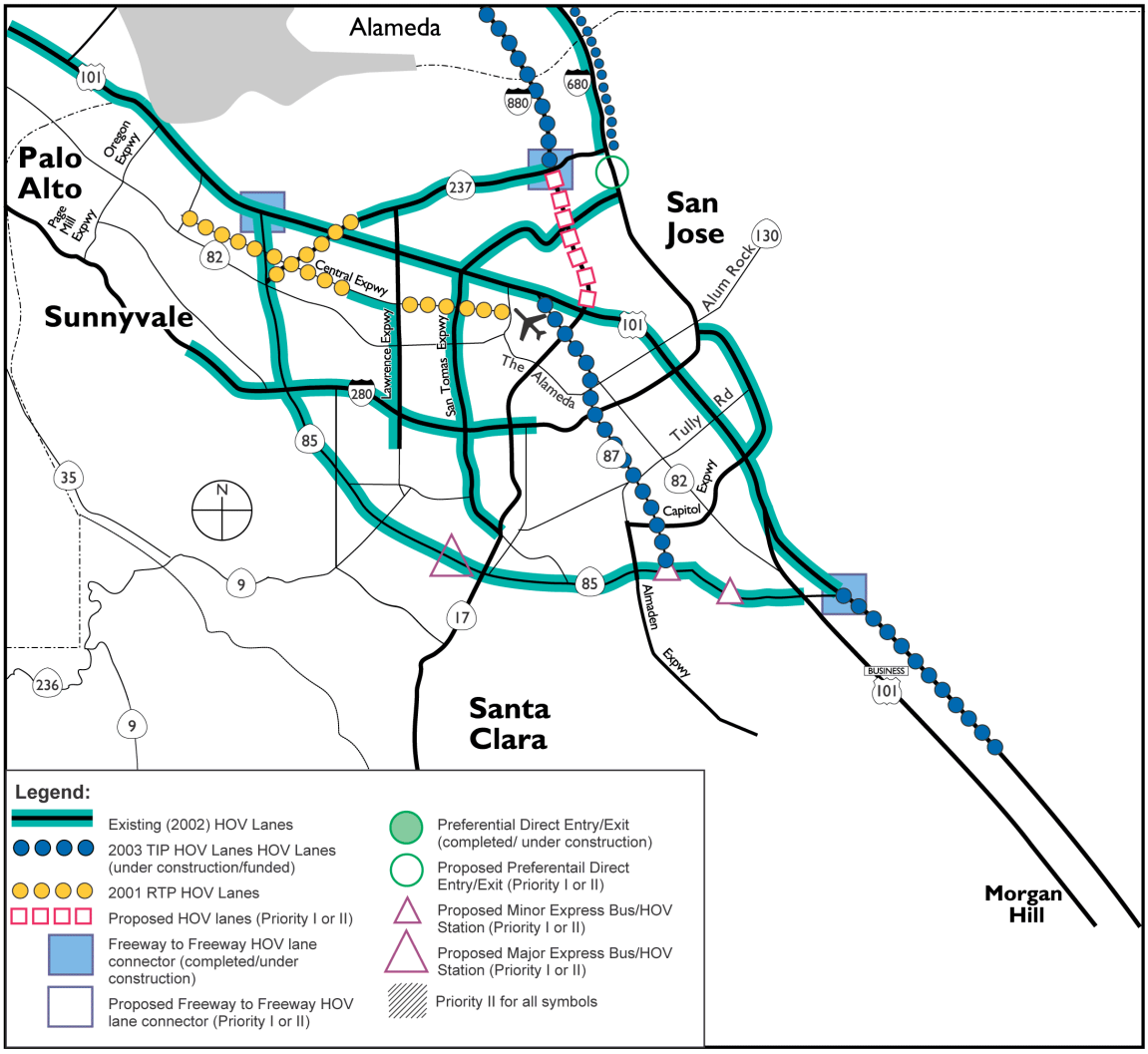


FIGURE 16

Priority 1 & 2 Recommended HOV Lane System Improvements

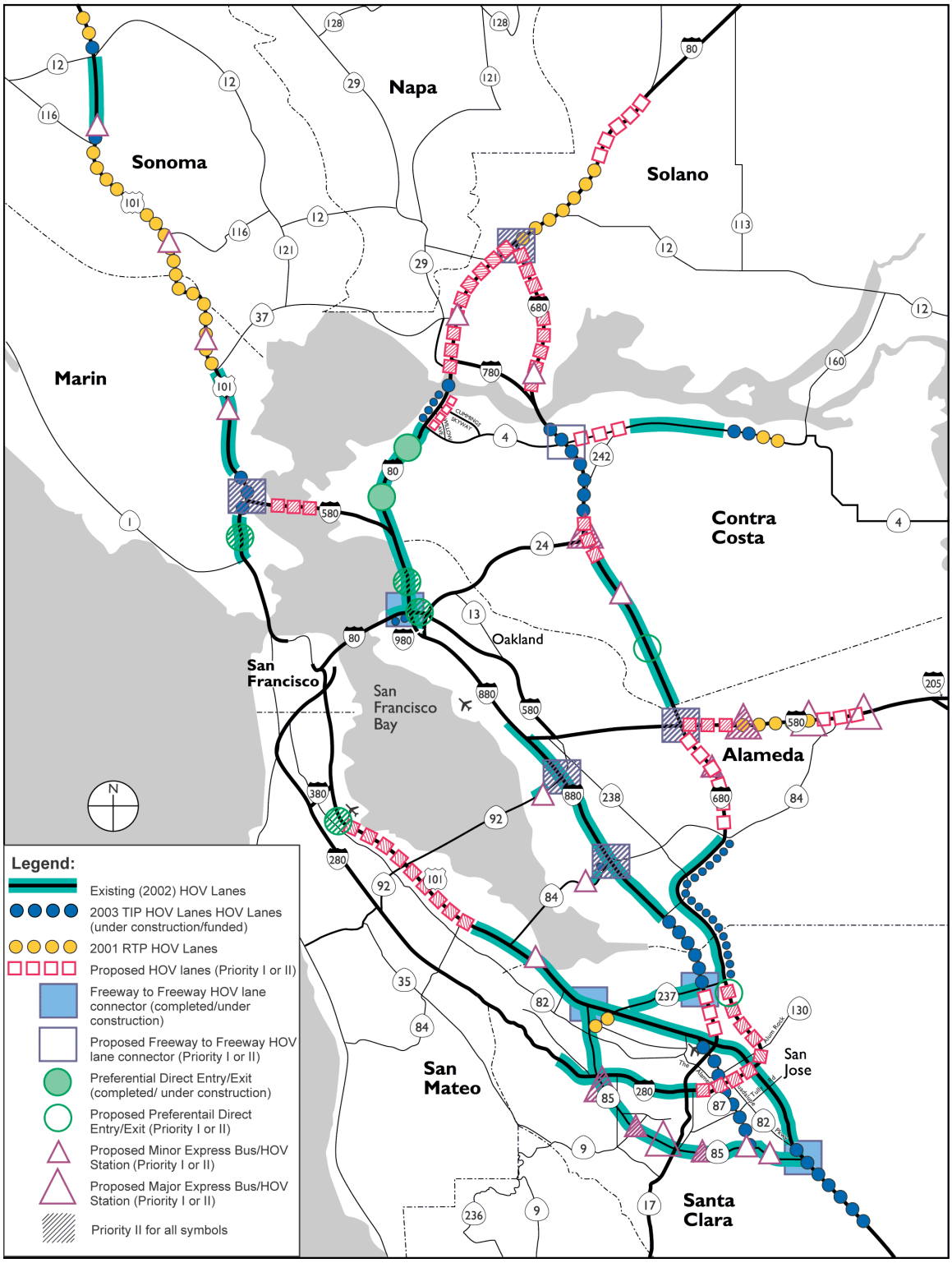


FIGURE 17

Priority 1 & 2 Recommended HOV Lane System Improvements: Santa Clara County

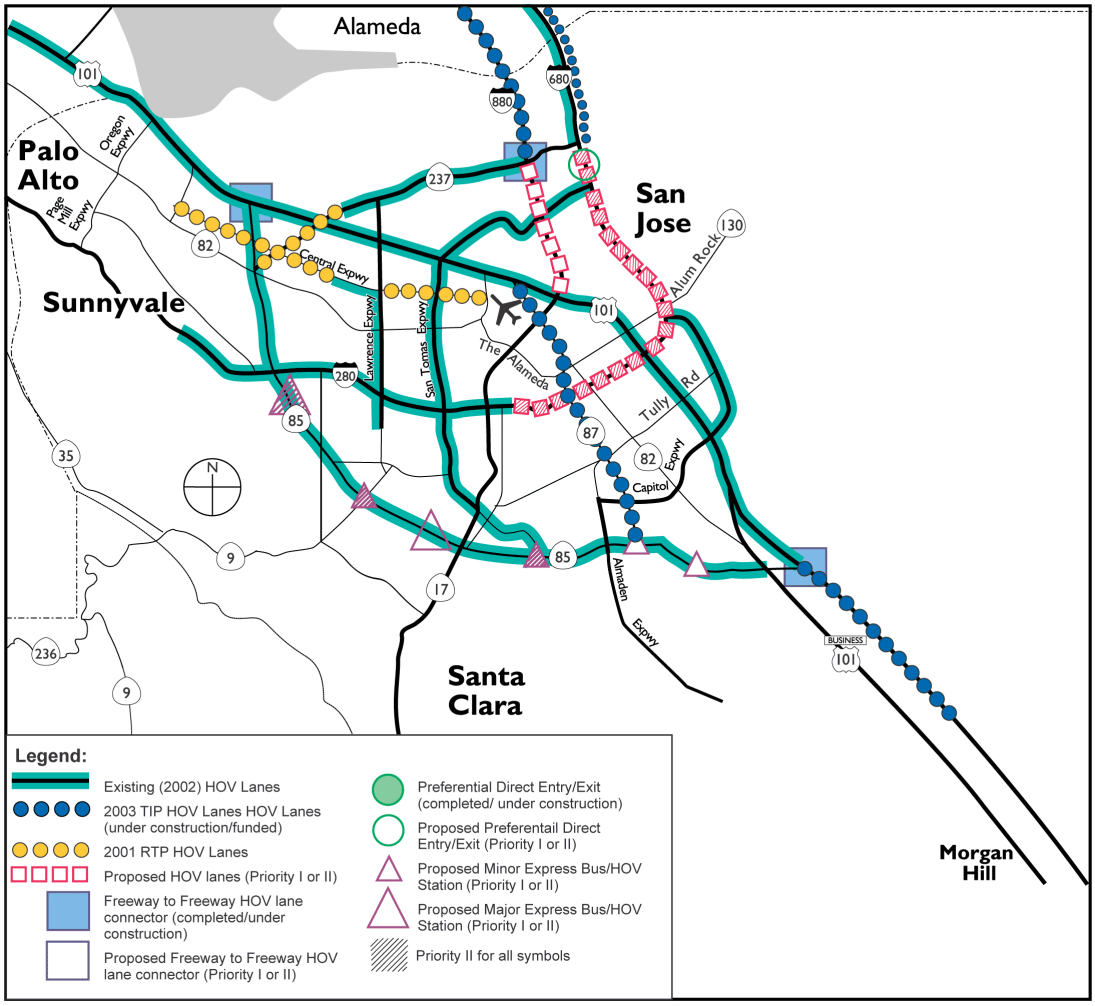


FIGURE 18

Table 4 – Summary of Existing and Proposed HOV Lane Mileage

	HOV LANE MILEAGE SUMMARY					
Corridor	**Existing**	**2003 TIP**	**2001 RTP**	**Priority I**	**Priority II**	**TOTAL**
Alameda County I-80	11.3	1.1	--	--	--	**12.4**
Alameda County SR 84	1.8					
Alameda County SR 92	3.0					
Alameda County I-580	--	--	7.2	11.1	3.4	**21.7**
Alameda/Santa Clara Counties I-680	14.0	14.0	--	16.9	--	**44.9**
Alameda County I-880	38.4	4.4	--	--	--	**42.8**
Contra Costa County SR 4	14.5	9.4	10.9	5.7	--	**40.5**
Contra Costa County I-80	19.6	2.7	5.4	3.3	--	**31.0**
Contra Costa County I-680	24.7	--	17.4	4.7	--	**46.8**
Marin County US 101	19.4	4.6	29.6	--	--	**53.6**
Santa Clara County SR 85	47.1	--	--	--	--	**47.1**
Santa Clara County SR 87	--	5.6	--	--	--	**5.6**
Santa Clara County US 101	49.1	19.6	--	--	--	**68.7**
Santa Clara County SR 237	10.3	--	6.5	--	--	**16.8**
Santa Clara County I-280	21.9	--	--	--	6.9	**28.8**
Santa Clara County I-680	--	see Ala 680	--	--	13.4	**13.4**
Santa Clara County I-880	--	see Ala 880	--	15.4	--	**15.4**
Santa Clara County Exwys	50.0	--	16.0			
San Mateo County US 101	13.2	--	--	--	22.0	**35.2**
Solano County I-80	--	--	16.4	14.3	18.4	**49.1**
Solano County I-680	--	--	--	--	22.5	**22.5**
Sonoma County US 101	10.0	--	50.7	--	--	**69.3**
Regional Total	**348.3**	**70.0**	**160.0**	**71.4**	**86.6**	**665.5**

10 RECOMMENDATIONS BY COUNTY AND CORRIDOR

Sonoma and Marin Counties

The recommended improvements in Sonoma and Marin counties are designed to support an HOV lane system that will run continuously in both directions from Santa Rosa to Mill Valley once roughly 70 new HOV lane miles are added with existing TIP and RTP funding, as illustrated in Table 4. The improvements also are designed to support one of the key express bus streams (Steam 1: Gold – Sonoma County to downtown San Francisco). This corridor has existing express bus and ferry services and the proposed improvements would augment the service between counties and to downtown San Francisco. Express bus service would be tailored to the corridor to complement future planned expanded ferry service and new Marin/Sonoma rail service.

Recommended Priority I improvements include four minor express bus stations – two in Sonoma County and two in Marin County. Recommended Priority II improvements include freeway-to-freeway HOV lane connections at the US 101/I-580 interchange and a preferential HOV entry and exit point adjacent to the Larkspur Ferry Terminal.

No infrastructure improvements are recommended on I-580 where the Stream 2: Gray - Marin County to Berkeley/Oakland via I-580 and I-80 express bus service is proposed. An HOV lane on I-580 was de-designated due to lack of sufficient use. HOV lanes formed by using the shoulders during peak hours in each direction on the bridge is recommended as a Priority II.

A summary of the recommendations by corridor is provided below.

Sonoma US 101

Infrastructure Improvements

Priority I

- Minor HOV lane express bus stop, Rohnert Park (Rohnert Park Expressway)
- Minor HOV lane express bus stop, Petaluma (Lakeville Rd)

Priority II

- None

Operational Improvements

- Support express service by adding service in the Gold Stream
- Consider implementation of HOT lane as a way to make effective use of excess capacity or as a transition from 2+ to 3+ occupancy requirement
- HOV lanes should operate in both directions during morning and afternoon peak periods

Marin US 101

Infrastructure Improvements

Priority I

- Minor HOV lane express bus stop, Novato (Alameda del Prado/Smith Ranch Road)
- Minor HOV lane express bus stop, Novato (Rowland Blvd)

Priority II

- Freeway-to-Freeway HOV connection, US 101/I-580
- Direct HOV access ramps, Larkspur (Sir Francis Drake Blvd)

Operational Improvements

- Support express bus service by adding service in the gold and gray streams
- HOV lanes should continue to operate in peak direction only (southbound a.m. and northbound p.m.)

Marin I-580

Infrastructure Improvements

Priority I

- None

Priority II

- None

Operational Improvements

- None

Solano and Napa Counties

The recommendations for Solano and Napa counties focus future HOV lane system investments on I-80 and I-680; all of the proposed improvements are in Solano County. The 2001 RTP includes roughly 16 miles of new HOV lanes on I-80 between I-680 and North Texas Street in Fairfield. Continuing the HOV lane east from North Texas Street to I-505 is recommended as a Priority I improvement. Completing the HOV connections to the Carquinez Bridge on I-80 and the Benicia Bridge on I-680 are recommended, but as Priority II improvements. If funded, these additions would create continuous HOV lanes from Solano County to jobs in Contra Costa and Alameda counties as well as connections to the Bay Bridge and San Francisco.

The recommended improvements in Solano County also are designed to support two proposed express bus streams: Stream 3: Blue – Solano/Napa counties to Downtown San Francisco and Stream 4: Orange – Solano/Contra Costa counties to Santa Clara County. In addition to providing direct access to destination employment centers, these streams also would link Napa and Solano County commuters to BART, Muni and VTA rail stations, which can provide distribution to a large number of additional employment sites.

The recommended Priority I improvements include minor express bus stations in the Marine World area near the I-80/SR 37 interchange and at the I-680/Lake Herman Road interchange. The Priority I minor express bus stations are recommended on freeway segments that would not have HOV lanes under the Priority I recommendations; they would provide support to express bus operation in HOV lanes south of the bridges. Freeway-to-freeway HOV connections at the I-80/I-680 interchange are recommended as Priority II improvements.

A summary of the recommendations by corridor is provided below.

Solano I-80

Infrastructure Improvements

Priority I

- New HOV segment, N Texas St to I-505
- Minor HOV lane express bus stop, Vallejo (Marine World area/SR 37)

Priority II

- New HOV lane segment, I-680 to Carquinez Bridge
- Freeway-to-Freeway HOV lane connection, I-80/I-680

Operational Improvements

- Support express service by adding service in the Blue Stream
- Support express bus service by identifying locations to implement bus rapid transit improvements on arterial streets that provide access to and from I-80 HOV lanes

Solano I-680

Infrastructure Improvements

Priority I

- Minor HOV lane express bus stop, Benicia (Lake Herman Rd) – Priority I

Priority II

- New HOV segment, I-80 to Benicia Bridge – Priority II
- Freeway-to-Freeway HOV connection, I-80/I-680 – Priority II

Operational Improvements

- Support express service by adding service in the Orange Stream
- Consider temporary use of shoulders for HOV and/or express bus use until permanent HOV lanes are constructed if the road is rebuilt with a third mixed-flow lane in each direction

Contra Costa County

The improvements in Western Contra Costa County are designed to support the already mature 3+ HOV lane on I-80 and the Bay Bridge HOV toll by-pass lanes. The I-80 HOV lanes will also support two proposed express bus streams: Stream 3: Blue – Solano/Napa counties to downtown San Francisco and a portion of Stream 2: Gray – Marin County to Berkeley/Oakland. The recommended Priority I improvements in Western Contra Costa County include eastbound HOV lanes on I-80 from SR 4 to the Carquinez Bridge and completion of the direct access ramps on I-80 at the Richmond Parkway and at Cutting Boulevard to provide access and egress to the north. There are no recommended Priority II recommendations in Western Contra Costa County.

In Central and Eastern Contra Costa County, the proposed improvements are designed to develop a currently limited HOV lane system. Although the 2003 TIP and 2001 RTP include roughly 15 lane miles of new HOV lanes on I-680 and 19 lane miles of new HOV lanes on SR 4, gaps would still remain in the HOV system. The I-680 HOV lanes would support the main north-south bus stream in the East Bay: Stream 4: Orange – Solano/Contra Costa Counties to Santa Clara County. The recommended Priority I improvements for Central and Eastern Contra Costa County include new HOV lanes on SR 4 between I-680 and SR 242, direct freeway-to-freeway HOV lane connection at the I-

680/SR 4 interchange (between the southern leg of I-680 and the eastern leg of SR 4 only), direct HOV access ramps on I-680 and Bollinger Canyon Road, and a minor express bus station at Sycamore Valley Road. A gap closure on I-680 between North Main and South Main through the I-680/SR 24 interchange and a major new express bus station at the Pleasant Hill or Walnut Creek BART station are recommended as Priority II improvements.

Although there are no HOV facilities on SR 24, a previous study of the corridor has recommended evaluation of a "queue jumper" lane for buses at the entrance to the Caldecott Tunnel in the off-peak direction using an inside lane that would normally carry traffic to the central bore.

No infrastructure improvements are recommended on I-580 where the Stream 2: Gray - Marin County to Berkeley/Oakland via I-580 and I-80 express bus service is proposed. An HOV lane on I-580 was de-designated due to lack of sufficient use. An HOV lane in each direction on the Richmond-San Rafael Bridge is recommended as a Priority II improvement by using the shoulders during peak hours.

A summary of the recommendations by corridor is provided below.

Contra Costa SR 4

Infrastructure Improvements

Priority I

- New HOV lane segment, SR 242 to I-680
- Freeway-to-Freeway HOV lane connection, I-680/SR 4

Priority II

- None

Operational Improvements

- Support express service by adding service in the Orange Stream
- Explore implementation of a HOT lane to take advantage of excess HOV lane capacity
- Continue to operate in peak direction only (westbound a.m. and eastbound p.m.)

Contra Costa SR 24

Priority I

- None

Priority II

- None

Operational Improvements

- Consider off-peak direction HOV "queue jumper" lanes as recommended in the SR 24/Caldecott Tunnel Corridor Study

Contra Costa I-80

Infrastructure Improvements

Priority I

- New HOV lane segment, eastbound from SR 4 to Carquinez Bridge
- Direct HOV lane access ramps, Richmond Pkwy (under construction)
- Direct HOV lane access ramps, Cutting Blvd (under construction)

Priority II

- None

Operational Improvements

- Support express service by adding service in the Blue and Gray streams
- Consider eliminating HOV lane in off-peak direction (eastbound a.m. and westbound p.m.) in accordance with the "I-80 Project Assurances"

Contra Costa I-580

Infrastructure Improvements

Priority I

- None

Priority II

- Add HOV lanes on both sides of the Richmond-San Rafael Bridge by taking the shoulders

Operational Improvements

- None

Contra Costa I-680

Infrastructure Improvements

Priority I

- Freeway-to-Freeway HOV connection, I-680/SR 4
- Direct HOV lane access ramps, San Ramon (Bollinger Canyon Rd)
- Minor HOV lane express bus stop, Danville (Sycamore Valley Rd)

Priority II

- New HOV segment, North Main Street to South Main Street
- Major HOV lane express bus stop, Pleasant Hill/Walnut Creek BART

Operational Improvements

- Support express service by adding service in the Orange, Green and Maroon streams
- MTC and Caltrans to evaluate the discrepancy between the proposed I-680 2+ occupancy requirement and the current 3+ requirement for HOV toll free passage at the Benicia Bridge
- Consider implementation of HOT lane as a way to make effective use of excess capacity or as a transition from 2+ to 3+ occupancy requirement
- Support express bus service by identifying locations to implement bus rapid transit improvements on arterial streets that provide access to and from I-680 HOV lanes

Alameda County

In Eastern Alameda County, increasing congestion on I-580 will necessitate the introduction of additional capacity through HOV lanes. Although HOV lanes are already included for some portions of I-580 in the RTP, it is recommended that these be expanded to stretch from Greenville Road to I-680 in both directions. These new I-580 HOV lanes would support the introduction of three new express bus streams:

- Stream 5: Maroon - Tri-Valley to Berkeley/Emeryville
- Stream 6: Green - Tri-Valley to San Mateo County
- Stream 7: Purple - Eastern Contra Costa County to Santa Clara County

Improvements are proposed to support regional transit centers in the Greenville Road/Vasco Road area and the Airway Boulevard/Isabel Avenue area. Proposals also include completion of the I-680 HOV lane gap between the portions to the north (beginning in Dublin) and south (Sunol Grade). The proposed improvements in Eastern Alameda County also would support one north-south express bus stream: Stream 4: Orange – Solano/Contra Costa Counties to Santa Clara County.

The Priority I recommendations for Eastern Alameda County include HOV lanes on I-580 from Greenville Road to Isabel Avenue, new HOV lanes on both sides of I-680 from I-580 to SR 84, and major express bus stations on I-580 at Airway Boulevard and Greenville Road. Priority II recommendations include extension of the I-580 HOV lanes west from Tassajara Road to I-680, a freeway-to-freeway direct HOV lane connection at the I-580/I-680 interchange, a major express bus station on I-580 at the Dublin/Pleasanton BART station, and a minor express bus station on I-680 at Bernal Road.

In Western Alameda County, a number of HOV lane improvement projects are identified at the three bridge approaches, to take advantage of the HOV bypass lanes and free tolls at the toll plazas. For the Bay Bridge, direct access ramps at Ashby Avenue and for the I-580/SR 24 approach are recommended as Priority II improvements. Also included in Priority II is the easterly extension of one of the south side Bay Bridge HOV lanes through the I-80/580/880 distribution structure. Adding an HOV lane to I-880 from the present northern terminus of the lane to the Bay Bridge did not seem to be feasible without using an elevated structure, which did not appear to be warranted.

In approaching the San Mateo Bridge, a minor express bus station on SR 92 at Clawiter Road is included as a Priority I improvement and a freeway-to-freeway direct connector at I-880/SR 92 is recommended as a Priority II improvement. The possibility of adding a reversible HOV lane on the San Mateo Bridge currently is being explored by MTC.

A freeway-to-freeway direct HOV lane connector at the I-880/SR 84 interchange also is recommended as a Priority II improvement to provide access to the Dumbarton Bridge. Finally, enhancements at the Dumbarton Bridge approach in Newark are envisioned that would intercept drivers using a regional park-and-ride lot. A minor express bus station on the Dumbarton Bridge approach is recommended as a Priority I improvement.

Similar to the recommendation for SR 24 in Contra Costa County, it is recommended that there be an evaluation of a “queue jumper” lane for buses at the entrance to the Caldecott

Tunnel in the off-peak direction, using an inside lane that would normally carry traffic to the central bore.

Bay Bridge HOV Lane Consideration

Consideration was given to taking eastbound and westbound mixed flow lanes on the Bay Bridge and designating them as HOV lanes. An analysis conducted by Caltrans District 4 indicated that taking Bay Bridge traffic lanes for HOV use would exacerbate congestion in the bridge corridor and provide little or no time savings for HOVs. Caltrans' analysis indicates that, in the westbound direction, the metering operation at the toll plaza is designed to ensure that the bridge itself operates with as little congestion as possible – even when incidents occur. The majority of the traffic queue is held upstream of the metering lights and HOVs get unimpeded access through the metering lights, often saving up to 20 minutes during the morning peak. Because the metering lights ensure that the bridge remains relatively uncongested, HOVs would not gain any substantial travel time savings by extending a westbound HOV lane across the bridge. In the eastbound direction, the three-lane approach also "meters" traffic transitioning to the five eastbound lanes on the bridge; once on the bridge, traffic flows fairly smoothly with little potential time savings for HOVs. Using one of the three eastbound approach lanes for HOVs would create severe freeway congestion that would back up onto local San Francisco streets making it difficult for HOVs and other vehicles to access the freeway. For these reasons, it is not recommended that Bay Bridge mixed flow lanes be designated as HOV lanes.

A summary of the recommendations by corridor is provided below.

Alameda SR 84

Infrastructure Improvements

Priority I

- Minor HOV lane express bus stop, Newark (Newark Boulevard)

Priority II

- Extend HOV lane to proposed freeway-to-freeway HOV connection, I-880/SR 84,

Operational Improvements

- Increase express bus service over the Dumbarton Bridge with the addition of the Purple Stream

Alameda SR 92

Infrastructure Improvements

Priority I

- Minor HOV lane express bus stop, Hayward (Clawiter Road)

Priority II

- Freeway-to-freeway HOV lane connection and gap closure, I-880/SR 92

Operational Improvements

- Increase express bus service over the San Mateo Bridge with the addition of the Green Stream
- Evaluate HOV reversible lanes on the bridge

Alameda I-80

Infrastructure Improvements

Priority I
- None

Priority II
- Direct HOV lane access ramps, Berkeley (Ashby Avenue)
- Provide additional left-side bus-only lane at the Bay Bridge toll plaza

Operational Improvements

- Reduce HOV violations from enhanced enforcement on the mainline segments, on the HOV ramps to the Bay Bridge toll plaza and at the toll plaza approach
- Support express service by adding service in the Blue and Gray Streams
- Consider eliminating HOV lane in off-peak direction (eastbound a.m./westbound p.m. only)

Alameda I-580

Infrastructure Improvements

Priority I
- New HOV segment, Isabel Avenue to Greeneville Road
- Major HOV lane express bus stop, Livermore (Airway Boulevard/Isabel Avenue)
- Major HOV lane express bus stop, Livermore (Greeneville Road/Vasco Road)

Priority II
- New HOV segment, I-680 to Tassajara Road
- Freeway-to-Freeway HOV connection, I-580/I-680
- Direct HOV access ramps, Oakland (I-580/SR 24 to the Bay Bridge HOV lanes)
- Major HOV lane express bus stop, Pleasanton (Dublin/Pleasanton BART station)

Operational Improvements

- Support express service by adding service in the Green, Purple and Maroon streams
- Explore implementation of HOT lane as a transition from 2+ to 3+ occupancy requirement
- Explore the peak-period, peak-direction use of shoulders west of I-680 as temporary HOV lanes until permanent lanes are built
- Support express bus service by identifying locations to implement bus rapid transit improvements on arterial streets that provide access to and from I-580 HOV lanes

Alameda I-680

Infrastructure Improvements

Priority I
- New HOV lane segment, I-580 to SR 84

Priority II
- Freeway-to-freeway HOV lane connection, I-580/I-680
- Minor HOV lane express bus stop, Pleasanton (Bernal Road)

Operational Improvements

- Support express service by adding service in the Green and Orange streams
- Explore the use of the northbound shoulders from SR 84, through the I-580/I-680 interchange to the existing HOV lane as a temporary HOV lane

Alameda I-880

Infrastructure Improvements

Priority I

- None

Priority II

- Freeway-to-freeway HOV lane connection, I-880/SR 84
- Freeway-to-freeway HOV lane connection, I-880/SR 92
- Widen West Grand/Maritime on-ramp for HOVs

Operational Improvements

- Support express service by adding service in the Navy Stream
- Explore extending the Bay Bridge approach HOV lane by using the northbound shoulder from I-980 to the existing HOV lane

Santa Clara County

The 2003 TIP and 2001 RTP included expansion of the HOV system in Santa Clara County on I-680, I-880, US 101 and SR 87 for a total of roughly 40 new HOV lane miles. Freeway-to-freeway direct HOV lane connections also are planned for the northern US 101/SR 85 interchange and at I-880/SR 237. Freeway-to-freeway direct HOV lane connections are under construction at the southern US 101/SR 85 interchange.

This study does not make HOV lane recommendations on County expressways. A Comprehensive County Expressway Planning Study being conducted by the Santa Clara County Roads and Airport Department is evaluating existing and proposed County expressway HOV lanes.

Additional HOV lane improvements are recommended in this project to close HOV gaps and to support three new express bus streams:

- Stream 4 – Orange – Solano/Contra Costa counties to Santa Clara County
- Stream 7 – Purple - Eastern Contra Costa County to Santa Clara County
- Stream 8 – Red – Southern Santa Clara County to San Francisco.

Priority I HOV lane extensions are recommended for I-680 and I-880 to reach US 101 from their current termini in northern San Jose/Milpitas. A Priority II HOV lane extension is recommended for I-280 to reach US 101. To enhance access, direct freeway connectors also are also proposed at Montague Expressway in Milpitas from I-680 (Priority I), and between US 101 and SR 85 in south San Jose (Priority II). Direct HOV lane connections are already currently under construction for the northbound US 101 to northbound SR 85 and southbound SR 85 to southbound US 101 connections at the above location. Therefore, the improvements recommended under the Priority II listing would be the southbound SR 85 to northbound US 101 connection and the southbound US 101 to the northbound SR 85 connection. Without direct connections, HOVs would need to leave the HOV lanes to access other roadways.

A new express bus corridor (Stream 8 – Red) is envisioned that would use the HOV lanes of Route 85 across the south edge of Santa Clara County. Major stations are proposed that would allow an interface with regional light rail stations, park-and-ride lots, and other

amenities: one at Winchester Boulevard as a Priority I improvement and one at Stevens Creek Boulevard as a Priority II improvement. Two minor express bus stations are proposed as Priority I improvements on SR 85 in San Jose, and two other minor express bus stations, one in San Jose and the other in Saratoga, are proposed as Priority II improvements on SR 85. This should allow the HOV lane on SR 85 to operate as a productive busway/HOV hybrid facility for its entire length. A minor express bus station also is recommended as Priority I improvement on US 101 in Palo Alto at Oregon Expressway.

A summary of the recommendations by corridor is provided below.

Santa Clara SR 85

Infrastructure Improvements

Priority I

- Major HOV lane express bus stop, Los Gatos (Winchester Boulevard/Vasona Junction)
- Minor HOV lane express bus stop, San Jose (Santa Teresa LRT/Cottle LRT)
- Minor HOV lane express bus stop, San Jose (Oakridge area/LRT connection)

Priority II

- Major HOV lane express bus stop, Cupertino (DeAnza College/Stevens Creek Boulevard)
- Minor HOV lane express bus stop, San Jose (Camden Avenue)
- Minor HOV lane express bus stop, Saratoga (Saratoga Avenue)

Operational Improvements

- Support express bus service by adding service in the Red Stream
- Consider implementation of HOT lane as a transition from 2+ to 3+ occupancy requirement
- Support express bus service by identifying locations to implement bus rapid transit improvements on arterial streets that provide access to and from SR 85 HOV lanes

Santa Clara US 101

Infrastructure Improvements

Priority I

- Minor HOV lane express bus stop, Palo Alto (Oregon Expressway)

Priority II

- Freeway-to-Freeway HOV connection, US 101/SR 85 (So. San Jose) (southbound SR 85 to southbound US 101 and northbound US 101 to NB SR 85 connectors currently under construction)

Operational Improvements

- Support express bus service by adding service in the Red and Purple streams (north of SR 237)

Santa Clara I-280

Infrastructure Improvements

Priority I

- None

Priority II

- New HOV segment, SR 17 to US 101

Operational Improvements

- Support express bus service by identifying locations to implement bus rapid transit improvements on arterial streets that provide access to and from I-280 HOV lanes

Santa Clara I-680

Infrastructure Improvements

Priority I

- New HOV lane segment, SR 237 to US 101
- Direct HOV lane access ramps, Milpitas (Montague Expressway)

Priority II

- Support express service by adding service in the Orange stream

Operational Improvements

- Support express bus service by identifying locations to implement bus rapid transit improvements on arterial streets that provide access to and from I-680 HOV lanes

Santa Clara I-880

Infrastructure Improvements

Priority I

- New HOV segment, SR 237 to US 101 – Priority I

Priority II

- None

Operational Improvements

- Support express service by adding service in the Purple Stream

County Expressways

Santa Clara County Roads and Airport Department's Comprehensive County Expressway Planning Study will be developing preliminary recommendations for elimination and addition of expressway HOV lanes.

San Mateo and San Francisco Counties

Operational improvements in this corridor are recommended along US 101. Although all of the proposed improvements are in San Mateo County, they also should benefit San Francisco, because they will improve access to jobs in San Francisco. The constrained and congested US 101 corridor would benefit from new HOV lanes south of Millbrae, so that a continual HOV lane would run from there into Santa Clara County. The project would represent a difficult design challenge, and is listed as a Priority II improvement unless a lane can be taken for HOVs as a result of the planned addition of auxiliary lanes. In addition, a connection with the intermodal station at Millbrae represents an important regional investment with anticipated high volumes of shuttles and regional buses. For this reason, a direct access treatment to link this station with US 101 is recommended as a

Priority II improvement. Adding an HOV lane between Millbrae and downtown San Francisco did not seem to be feasible without using an elevated structure, which did not appear to be warranted.

A summary of the recommendations by corridor is provided below.

San Mateo US 101

Infrastructure Improvements

Priority I

- None

Priority II

- New HOV lane segment, Redwood City to Millbrae Avenue
- Direct HOV lane access ramps, Millbrae Ave

Operational Improvements

- Support express service by adding service in the Red and Green streams

11 AIR QUALITY ANALYSIS

The analysis of HOV lane emissions is included as a "Further Study Measure" in the *2001 Ozone Attainment Plan*. This section of the HOV Plan update summarizes the analysis of HOV lane emission benefits conducted for the Further Study Measure. The analysis combines the results of MTC's travel demand forecast model with the latest Bay Area motor vehicle emission factors developed by the California Air Resources Board (CARB) to quantify emission benefits.

The Further Study Measure component of the HOV Master Plan update focuses on the air quality implications of the HOV Master Plan and also provides summary comparisons of the transportation performance of different HOV lane configurations.

Alternatives Evaluated

The HOV lane analysis first defined a set of discrete HOV lane, mixed flow lane and express bus alternatives that were then analyzed using MTC's travel demand forecast model:

1. **2003 TIP.** Includes all existing HOV lanes and HOV lanes that are programmed for funding in the 2003 TIP
2. **Mixed Flow.** Converts all HOV lanes in Alternative 1 to mixed flow lanes open to all traffic.
3. **HOV Master Plan.** Includes all HOV lanes in the 25-year *Regional Transportation Plan*, plus additional lanes (Priority 1) recommended for expansion in this study.
4. **HOV Lanes with Increased Occupancy Requirements (2+ to 3+).** All HOV Lane Master Plan lanes have 3+ occupancy requirements.
5. **HOV Master Plan with Express Bus.** Includes the HOV Lane Master Plan system with the plan's proposed express bus system operating on HOV lanes.

6. **Convert Select Mixed Flow Lanes to HOV Lanes.** Includes all Alternative 1 HOV lanes and converts mixed flow lanes to HOV lanes in select corridors (see Figure 19); also includes the plan's proposed express bus system operating on HOV lanes

Methodology

The HOV lane configurations defined above were input into the MTC travel demand model's transportation network for 2010 and travel forecasts were developed for each configuration. The travel demand forecast model estimates carpool and transit use based on travel time, cost, and other factors. Outputs from the travel model affecting regional emissions include total vehicle miles of travel (VMT), speeds in the mixed flow and carpool lanes (freeway speeds), and total vehicle trips (trip starts).

To analyze regional motor vehicle emissions, the latest version of CARB's EMFAC model was employed. The current model provides updated emission rates for various vehicles (passenger cars, trucks and buses) based on their age, engine characteristics and other factors. In the EMFAC model, the emission rates are combined with travel forecast model outputs of vehicle activity to calculate total mobile source emissions.

The following steps were performed to calculate mobile source emission inventories in this study:

Step 1: The MTC travel demand model was run for all alternatives to generate total vehicle trips, vehicle miles of travel (VMT) and vehicle miles of travel by speed range.

Step 2: The travel demand model outputs were processed to produce three variables by county:

a) VMT
b) number of trips/engine starts
c) hourly speed distributions

Step 3: For each county and alternative, the three variables were incorporated into the EMFAC input file using the "What If Scenario" (WIS) generator tool.

Step 4: Results for reactive organic compounds and nitrogen oxides (ROG and NOx are precursors to ozone formation) were tabulated (along with travel characteristic data) by county and summed.

Transportation Results

Travel activity forecasts were analyzed for five major statistics, which are illustrated in the Figures below:

1. Vehicle miles of travel (Figure 20)
2. Number of carpools (Figure 21)
3. Number of transit riders (Figure 22)
4. Average freeway speed (Figure 23)
5. Vehicle Hours of Travel (Figure 24)

Figure 19

HOV Master Plan Alternative 6 –
Conversion of Select Mixed Flow Lanes to HOV Lanes

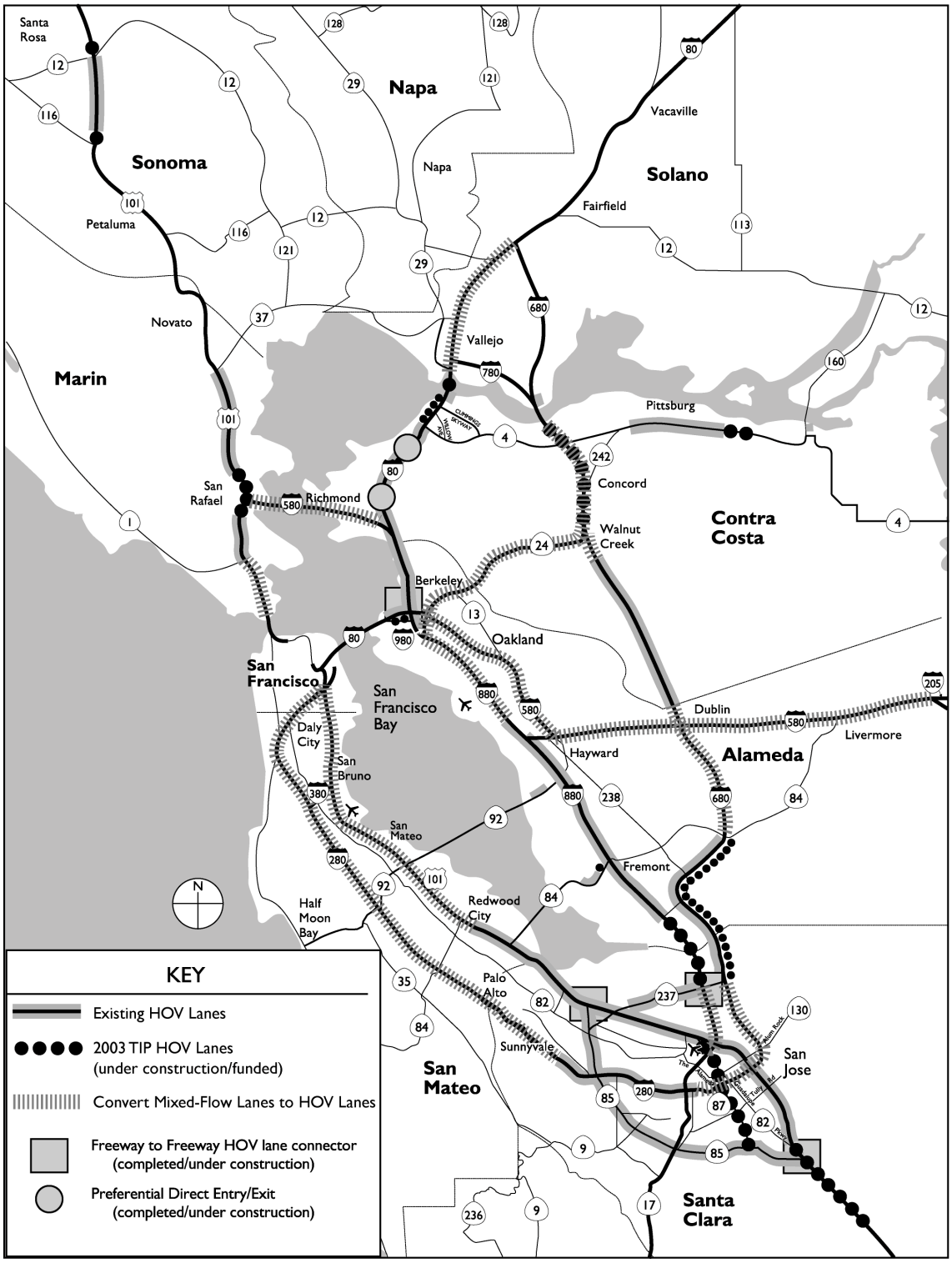


Figure 20

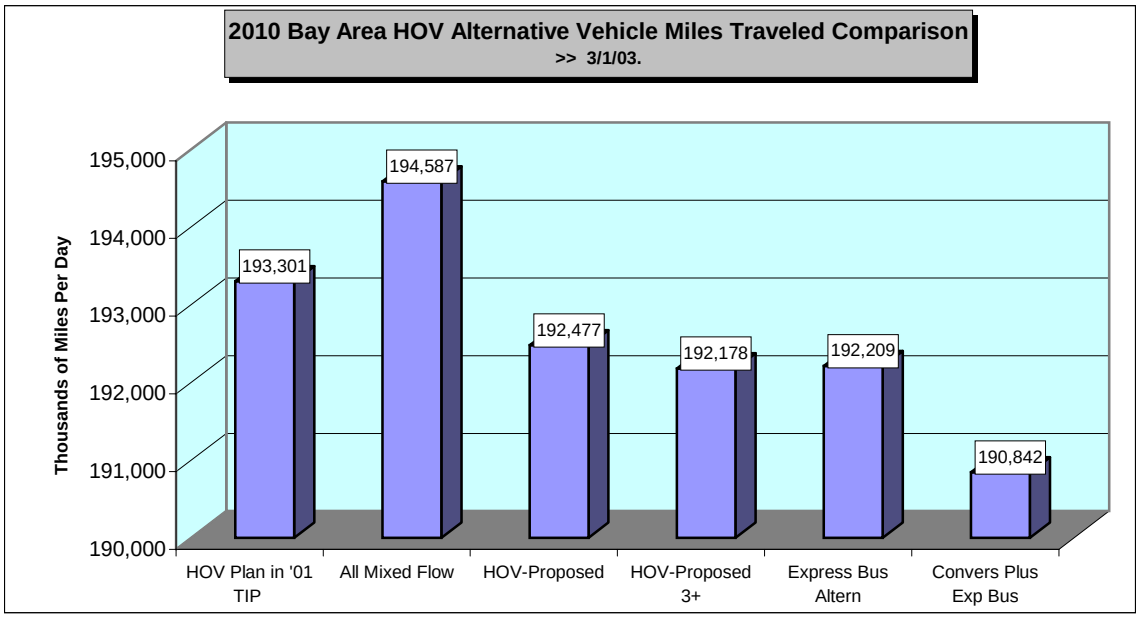


Figure 21

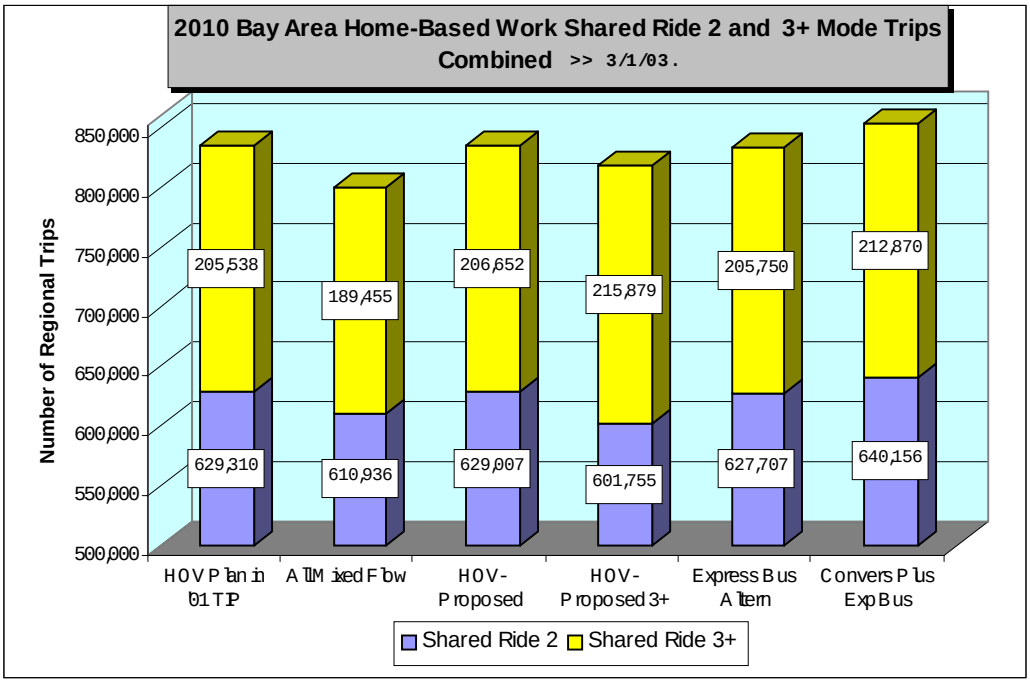


Figure 22

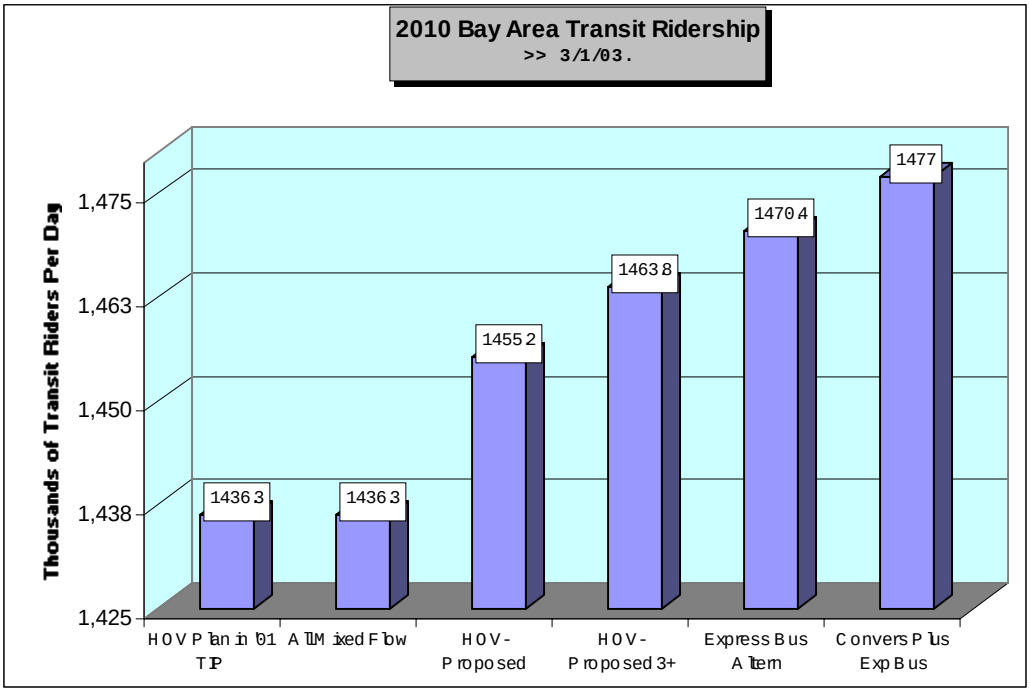


Figure 23

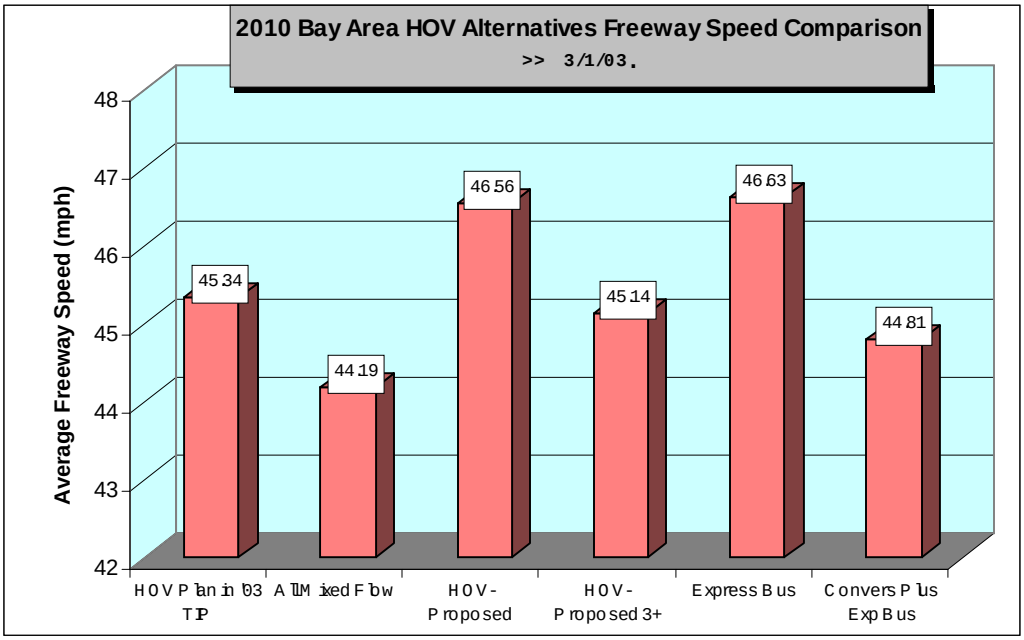
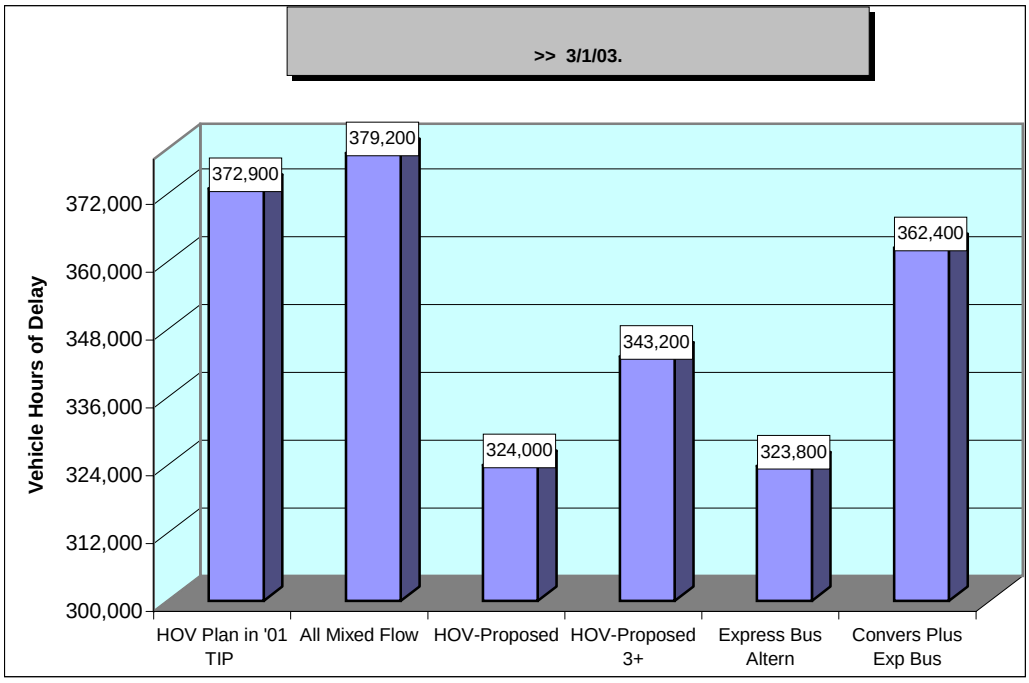


Figure 24



Overall differences in any measures at the regional level are small, since the HOV system and express buses operating on HOV lanes are just one component of a larger regional transportation network. Summary conclusions are as follows:

- HOV lane alternatives perform better than mixed flow lane alternatives.
- Carpool use (combined 2+ and 3+) is lowest for the mixed flow lane alternative and highest for the conversion of some existing lanes to HOV with express bus service. The difference in total carpools between the conversion alternative and the recommended HOV Master Plan is about 17,000 daily carpool trips (about a 2% difference).
- Among HOV alternatives, vehicle hours of delay are highest when some existing mixed flow lanes are converted to HOV lanes (with express bus), and lowest with the proposed HOV Master Plan.
- Restricting HOV lanes in the Master Plan to 3+ person carpools causes increases in vehicle delays, since the 2+ person carpools are shifted back into the crowded mixed flow lanes increasing congestion in these lanes.
- Regional transit ridership is highest when some existing mixed flow lanes are converted to HOV with express bus service. The difference in transit ridership between this alternative and the HOV Master Plan is about 6,600 daily transit trips in 2010 (a 0 .4% increase).

Other Transportation Issues

A question has been raised in the past about whether HOV lanes may induce more vehicular traffic. Answering this question involves a qualitative response, as there are not analytical ways to address it, certainly not within MTC's travel model framework.

Answering this question further requires a common understanding of what is meant by induced traffic, and secondly an understanding of the long-term relationships between freeway demand and capacity. Most aspects of individual or induced travel, including time of day shifts, routes shifts, and modal shifts (e.g. bus to auto) are directly handled in the MTC forecasts. That is, some of the travel on new HOV facilities that is perceived as "new" would actually be traffic that has shifted as described above. A second type of induced traffic relates to new trips that would otherwise not have been made had additional freeway capacity not been provided. Since most Bay Area freeway corridors will be congested in the future, due to projected growth in regional population and jobs, the peak direction commute period will have little available capacity that could induce individuals to take extra trips—with or without HOV lanes. Bay Area HOV lanes currently operate as mixed flow lanes during non-commute periods. Non-commute trips (e.g. shopping, recreational) show lower sensitivity to time and cost variables in traditional models; therefore, the availability of new capacity would likely be a weak incentive to induce additional non-commute trips.

Air Quality Results

The key air quality questions that were addressed in this study are:

1. What are the differences in regional emissions (ROG and NOx), comparing the HOV alternatives to mixed flow lane alternatives?

2. Which HOV lane alternatives provide the lowest emission reductions?

The first question is addressed by comparing the 2003 TIP (Basecase) with its HOV lanes to the same freeway network with no HOV lanes. The second question is addressed by comparing emissions among the various HOV lane/express bus configurations. Figures 25 and 26 illustrate these comparisons.

Emissions with and without HOV lanes. Converting all HOV lanes in the TIP to mixed flow lanes would produce about 1.3 more tons daily of ROG and 0.9 more tons of NOx. Put another way, HOV lanes would reduce regional ROG by about 1% and NOx by about 0.4%.

Emissions from various HOV configurations. All HOV lane alternatives show lower emissions than the mixed flow alternative (Alternative 2). The HOV Lane Master Plan with express buses produces the lowest amount of ROG followed by the HOV Master Plan; however, the difference is only about 0.2 tons per day (0.2% regionally). The HOV lane alternative with the lowest NOx is the conversion of some mixed flow lanes to HOV with express bus service. The lower NOx emissions result from slowing traffic down in the mixed flow lanes, as they become more congested (a consequence that emanates from the relationship between NOx and average speed).

Figure 25

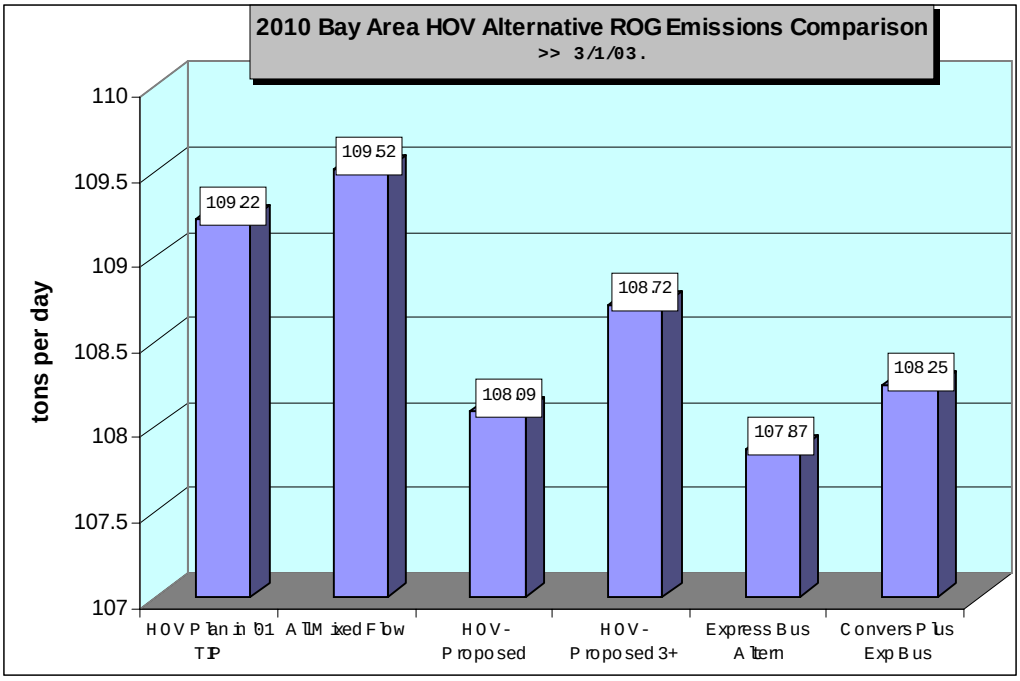
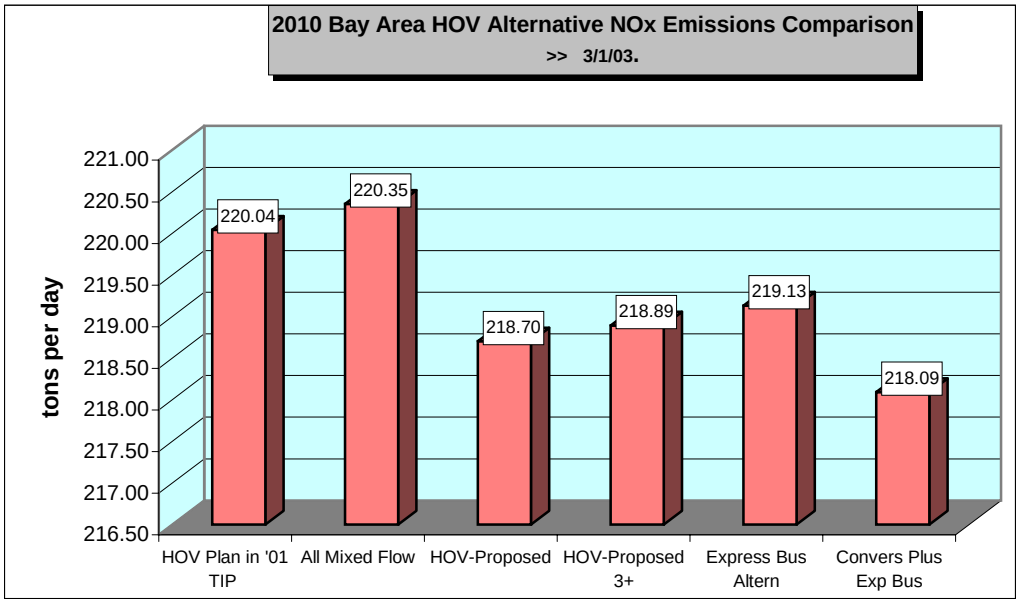


Figure 26



Conclusion

Like most TCMs HOV lanes reduce both ROG and NOx. The region's air quality control strategy has historically focused on obtaining more ROG reduction than NOx as the most efficient path to attainment of the federal ozone standard. Therefore, the net impact of HOV lanes on emissions is mixed due to this simultaneous reduction of both pollutants.

For a number of years, HOV lane emission benefits in regional air quality plans have been accounted for in the "baseline" emission inventory for the SIP. This is the preferred approach, rather than identifying HOV lanes as a separate TCM, since it provides for a more systematic analysis of the transportation network and is consistent with the way the transportation air quality "conformity" analysis has been carried out under the regulations promulgated by the US Environmental Protection Agency.